Hospital Nursing Staff Ratios and Quality of Care

Final Report on Evidence, Administrative Data, an Expert Panel Process, and a Hospital Staffing Survey

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The UC Davis Center for Health Services Research in Primary Care
Richard L. Kravitz, MD, MSPH, Director,
and
The UC Davis Center for Nursing Research
Mary Jane Sauvé, RN, DNSc, Director

UC DAVIS PROJECT STAFF

Richard L. Kravitz, MD, MSPH	Co-Principal Investigator
Mary Jane Sauvé, RN, PhD	Co-Principal Investigator
Margaret Hodge, RN, EdD	Co-Investigator
Patrick S. Romano, MD, MPH	Co-Investigator
Michael Maher, PhD	Professor of Accounting
Steven Samuels, PhD	Statistician
Danielle Harvey, PhD	Statistician
Valerie A. Olson	Project Coordinator
Julie Cahill, MPH	Analyst
Michael Gallagher, MSII	Programmer/Analyst
Judith Welsh, RN	Medical Librarian
Penny Barath	Administrative Assistant

CONSULTANTS

Steven Asch, MD, MPH	RAND Corporation
Thomas Lang, MA	Tom Lang Communications

A C K N O W L E D G E M E N T S

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Introduction

California Assembly Bill 394 requires the State Department of Health Services (DHS) to adopt regulations that establish minimum nurse-to-patient ratios within acute care general, special, and psychiatric hospitals. On behalf of the UC Office of the President, the UC Davis Center for Health Services Research and the UC Davis Center for Nursing Research are providing analytic and technical support to DHS as it considers various policy options.

In this final report, we review the available empirical literature on the relationship between nurse staffing and quality of care, describe the results of our analysis of hospital financial and discharge data obtained from the California Office of Statewide Health Planning and Development (OSHPD), summarize the deliberations of an expert clinical panel concerning the best nurse-sensitive indicators for tracking the effects of AB 394 on patient, provider, and institutional outcomes, and describe the results of an analysis of a survey designed to collect information on current staffing patterns in California acute care hospitals.

Systematic Review of the Literature

Project staff, in conjunction with DHS and a five-member Nursing Evidence Report Advisory Committee, identified four general questions to be addressed in the review: 1) What effect does nurse staffing have on patient outcomes, such as mortality, falls, pressure ulcers, and the like? 2) What effect does nurse staffing have on outcomes related to nurses in their role as employees, such as retention, job-related stress, or injuries? 3) What effect does nurse staffing have on institutional outcomes, such as labor costs, rehospitalization rates, or hospital length of stay? and, 4) Is there evidence to justify setting specific minimum nurse-to-patient ratios for nursing units in acute-care hospitals?

A medical librarian then conducted comprehensive literature searches on these questions using several standard databases. Article titles and abstracts from the searches were screened, and articles of potential interest were retrieved. To be included in the analysis, the article must have been published since 1980 and have reported: 1) original research that was 2) conducted in the United States, 3) in acute care, rehabilitation, or psychiatric hospitals, and 4) that tested the effect of some measure of nurse staffing level or nurse staffing skill mix on patient, employee, or institutional outcomes. Articles that met these inclusion criteria were reviewed by two staff members, who systematically abstracted specific data on a standard form. The findings of each study were then summarized and organized in a series of evidence tables. The clinical importance and statistical significance of each finding were considered when interpreting the evidence.

The literature searches identified 2870 articles of potential interest. Of these, 458 were selected for retrieval by at least one abstractor. Of the articles selected for retrieval, 456 (99.5%) were obtained. Of the retrieved articles, 419 were rejected for not meeting the inclusion criteria or for not reporting key information, leaving 37 articles and 266 individual findings for analysis.

Although the evidence is not compelling, it does suggest probable inverse relationships

between: 1) the number of RNs, and to a lesser extent, RN skill mix, and hospital mortality, 2) the number of RNs and, to a lesser extent, RN hours worked per patient day, and rates of pneumonia, and 3) total nursing hours worked per patient day and, to a lesser extent, RN skill mix, and hospital length of stay. In addition, the evidence suggests possible, at least statistical, relationships between nurse staffing and rates of nosocomial infections, urinary tract infections, pressure ulcers, and nursing documentation. Increasing the number of RNs or enriching the RN skill mix does not appear to increase costs and may even reduce costs when the expenses of adverse patient outcomes are considered.

Finally, almost all the studies included in the analysis, whether or not they studied specific nurse-to-patient ratios, adjusted their analyses for both the case mix of the patients (severity of illness) and the skill mix of the nursing staff (the ratio of RNs to other nursing personnel). Thus, the literature offers no support for establishing minimum nurse-to-patient ratios for nursing units in acute-care hospitals, especially in the absence of adjustments for case mix and skill mix.

Empirical Analysis of OSHPD Data

We conducted an analysis of hospital financial and discharge data obtained from the California Office of Statewide Health Planning and Development (OSHPD) in order to accomplish three general objectives. First, we wished to describe levels of nurse staffing (i.e., the distribution of nurse staffing ratios) at the nursing unit level in California hospitals from the most recent possible reporting period (1998-99). Second, we wanted to assess the likely effects of any new regulations on nurse manpower requirements and costs across California hospitals. Third, we wished to assess both the baseline ratios and the likely consequences of imposing varying staffing standards across different types of hospitals in different regions of the state.

While productive nursing hours do not translate directly into nurse to patient ratios and there is considerable variation in staffing among hospitals, the data indicate that average nurse staffing in California is roughly as follows: between 1:1 and 1:2 in critical care units; somewhat leaner than 1:4 in general medical care units and a bit richer in telemetry units; better than 1:3 in pediatric units; and leaner than 1:5 in subacute care units and psychiatric units within specialized psychiatric hospitals. Obviously, many hospitals staff at ratios richer than the average, while many staff leaner. In addition, productive hours per patient day will tend to underestimate nurse staffing levels if a substantial fraction of "productive nursing hours" are spent away from the bedside, for example, in training exercises or performing administrative tasks.

The staffing proposals submitted by AB 394 stakeholders vary widely and have tremendously different implications for the proportion of hospitals in staffing deficit, the number of nursing FTEs required to make up the deficits, and the costs of redressing the deficits. At one extreme, the recent proposal by the California Nurses Association to staff general medical units at 1:3 would place 92% of non-Kaiser hospitals in deficit and require 5586 licensed nurses costing $279.9 million to redress deficiencies. At the other extreme, the 1:10 proposal by the California Hospital Association would place only 4% of hospitals in deficit and require 74 nurses ($3.7 million) to make it up.

Although these findings have implications for the implementation of AB394 regulations, our projections are based on a number of assumptions that merit further examination: that

productive hours can be translated into nurse-to-patient ratios, that average staffing levels approximate minimum staffing levels, that "fractional nurses" are available for purchase at current (average) wage rates, that nurses are non-fungible across units because no units are currently "over-staffed," and that hospitals will be as efficient in using nursing resources after redressing nursing deficits as they were in the reporting period that is the basis for our data collection.

Expert Panel Process

The purpose of the expert panel exercise was to identify nurse-sensitive indicators with the potential for use in the evaluation of specified nurse to patient ratio regulations. In consultation with clinician investigators, project staff derived 79 potential indicators from the evidence gathered during the systematic literature review. Using a modified Delphi Expert Panel process developed by RAND, a panel of 9 nursing experts representing a variety of hospital types, geographic regions, and clinical specialties were selected to rate the indicators on a 9-point scale along the dimensions of validity, feasibility, and overall suitability. Panelists were also encouraged to identify additional indicators they felt were appropriate for evaluating nurse to patient ratios in specific areas such as emergency departments, or peri-anesthesia care units.

After completing an anonymous pre-rating process and then participating in a day-long panel meeting to discuss the indicators and perform their final ratings, the panelists passed 9 of 79 indicators (11%) as suitable outcomes for evaluating the impact of AB394. These are: 1) risk adjusted mortality, overall, determined using administrative data, 2) hospital length of stay, medical patients, 3) failure to rescue, determined using clinical data, 4) failure to rescue, determined using administrative data, 5) patient satisfaction, determined using a survey, 6) patient satisfaction with pain management, determined using a survey, 7) completion of patient teaching, determined using a survey, 8) perceptions of quality of care, as perceived by nurses, determined using a survey, and, 9) work-related injuries, musculo-skeletal. In addition, 14 of 79 indicators (16%) were rated as potentially suitable and could be considered for use in the evaluation process.

The use of this process for assessing structural components of care, such as nurse staffing, is an innovative use of the modified Delphi approach. The results of this phase of the project demonstrates that this is a valid method for identifying indicators appropriate for use in outcomes research with a focus on structural predictors of quality in health care.

General Acute Care Hospital Staffing Survey

A General Acute Care (GAC) Hospital Staffing Survey, designed collaboratively by DHS Licensing and Certification and UC Davis project staff, was conducted to collect cross-sectional data on hospitals' nursing workforce and staffing practices, and to assess patient-to-nurse staffing ratios within selected AB394 unit types. Although the yearly OSHPD Hospital Disclosure report contains data that can be used to estimate productive licensed nurse hours per patient day, these data are aggregated at the cost-center level and cannot be converted to patient-to-nurse ratios for specific shifts on specific units. Therefore, the GAC Hospital Staffing Survey analysis was structured to generate weighted estimates of true patient-to-nurse ratios for selected nursing units, estimate the statewide nursing deficit (in FTEs) under various AB394 regulatory proposals, estimate the financial impact associated with bringing hospitals into compliance with

the various proposals, and to explore the relationships between patient-to-nurse ratios derived from the 2001 survey and comparable ratios estimated from 1998-99 OSHPD data.

The survey collected staffing data for one randomly selected unit of each type from a stratified probability sample of 80 GAC hospitals, and for the ten hospitals operated by the California Department of Developmental Services, Department of Corrections, Department of Mental Health, and Department of Veterans Services. The GAC hospital survey included 10 University of California teaching hospitals, 10 Kaiser hospitals, 20 rural hospitals, 10 public (city or county) hospitals, and 30 other private hospitals. For each hospital, surveyors ascertained the number of RNs, LVNs, unlicensed staff, and patients in each sampled unit at the beginning of the surveyed shift, for all shifts during the past seven days, and for all shifts on ten randomly selected days during the previous three months. In addition, surveyors collected data on the demographic and educational characteristics of each nurse on duty in each sampled unit, and supplemental information on hospital operations that might explain variations in staffing patterns.

The nursing demographic data indicate that general acute care hospitals in California have diverse nursing staffs with a variety of educational qualifications, employment statuses, and experience. Most types of units rely about equally upon BSN and AA graduates. Although full-time nurses represent at least half of the staff in most types of units, emergency departments, psychiatric units, and postpartum units rely quite heavily on part-time and per diem nurses. Average experience is very high for RNs in labor and delivery, postpartum, and postanesthesia units. Nurses in subacute, combined stepdown/ telemetry, and oncology units are the least experienced, on average. These data confirm that a substantial percentage of inpatient nurses, outside subacute units, are likely to retire in the next decade.

Our weighted staffing analysis indicates that acute care hospitals also vary widely in the number of patients per licensed nurse, across most types of units. Staffing levels are relatively homogeneous on labor and delivery (interquartile range, 0.9-1.3) units, whereas they are relatively heterogeneous on postpartum (interquartile range, 4.0-6.4), psychiatric (interquartile range, 3.5-6), subacute (interquartile range, 5.5-10.7), and mixed (interquartile range, 3.7-6) units. Average staffing levels observed in this survey were generally similar to average staffing levels estimated in Section II from OSHPD Hospital Disclosure reports, although staffing for some types of units could not be estimated from OSHPD data. The major exception was subacute units, for which we estimated a median of 5.6 patients per nurse from OSHPD data, but we observed a median of 7.2 patients per nurse in this survey.

The nursing FTE deficits estimated from the survey are substantially greater than those estimated in Section II using OSHPD Hospital Disclosure reports. We attribute this difference principally to the fact that the former estimates are based on separate tallies of nursing deficits on each sampled shift in each sampled unit, whereas the latter estimates are based on average annual staffing levels for all units of the same type within a hospital. With variability in nurse staffing and patient acuity across shifts and days, a hospital may meet the required patient-to-nurse ratio on average, while being understaffed on up to about half of all shifts. The L&C proposal would require acute care hospitals in California to hire approximately 4,880 additional nurses, assuming that hospitals choose not to reassign staff who are currently working on shifts or units that are more generously staffed than the regulations would allow. We are 90% confident that the number of additional nurses to be hired in the first phase of AB 394 implementation will not

exceed 5,820. The cost of hiring these additional nurses will be about $330 million per year, at 1999-2000 wage and fringe benefit rates. Given our assumptions about nursing wages and skill mix, we are 90% confident that this cost will not exceed about $393 million per year, at 1999-2000 wages an fringe benefit rates.

With the implementation of stricter staffing standards for medical, surgical, combined medical/surgical, and mixed units in 2004, the total nursing FTE deficit will rise to about 7,230 and the financial impact will rise to about $486 million per year. The financial impact on State-operated hospitals will be modest, as the total nursing FTE deficit for these hospitals will be about 30 in 2003 and 45 with full implementation of the proposed regulations in 2004.

Margaret Hodge, RN, EdD; Thomas Lang, MA; Mary Jane Sauvé, RN, DNSc; Valerie Olson; Richard L. Kravitz, MD, MSPH; Patrick S. Romano, MD, MPH

Nurses in acute health care settings are convinced that there is a link between organization variables, including the numbers and types of nursing staff available to provide care, and the quality of nursing care that patients receive.[1]

In 1996, the IOM reported that it found little evidence to support the reports and testimony provided by care givers that staffing levels had an adverse effect on the care being given.[2]

INTRODUCTION

The Problem: Setting Minimum Nurse Staffing Levels

The growth of managed care has had major financial implications for health care delivery.[3,4] Two implications are especially important. First, hospitalized patients are more acutely ill throughout their hospital stay than in previous years and thus require more care.[4-7] Second, staffing levels of patient care personnel— registered nurses (RNs), licensed practical nurses (LPNs), and unlicensed assistive personnel (UAP)—have been reduced to lower costs.[4-7] Of concern is whether the increased acuity of patients and the decreased numbers of patient care personnel have threatened the quality of medical care in acute care hospitals.[4-8]

To address this concern, the California State Assembly passed Assembly Bill 394 in 1999. Briefly, the bill requires the California State Department of Health Services (DHS) to establish minimum nurse-to-patient ratios in acute care general, special, and psychiatric hospitals.[1] (The history of the bill and descriptions of the stakeholders concerned with its implementation are given in a report from the Center for the Health Professions, University of California, San Francisco, *Minimum Nurse Staffing Ratios in California Acute Care Hospitals*. [9]) More pragmatically, the purpose of this systematic review is to assemble evidence that will allow the State to resolve differences between a number of competing proposals. For example, proposed minimum nurse-to-patient ratios for the day shift of typical medical-surgical nursing units range between 1:4 and 1:10. Ideally, the evidence developed here would allow the State to determine which ratio in this range, irrespective of nursing skill mix, is safe, efficacious, and cost-effective.

Scope and Components of the Systematic Literature Review

In consultation with other UC researchers and a Nursing Evidence Report Advisory Committee (NERAC), we performed a systematic review of the literature on the relationship between nurse staffing levels and patient, employee, and institutional outcomes in acute care

[1] Acute psychatric hospital staffing will be addressed in a separate study, conducted by the UC Davis Center for Nursing Research. In addition, there are currently no licensed "special" hospitals in California.

hospitals. The five-member NERAC helped to identify the criteria for inclusion of articles, the data to be abstracted, and the scales on which internal validity and generalizability would be graded. The NERAC also recommended sources of relevant studies.

With the assistance of a medical librarian, we identified relevant articles from the literature. Article titles and abstracts were screened, and articles of potential interest were then retrieved and evaluated against a set of eligibility criteria. Selected articles were reviewed by one of two abstractors, who systematically abstracted specific data on a standard form.

From the abstracted data, we constructed evidence tables that addressed each of the three classes of outcomes. The NERAC reviewed the evidence tables and the associated analysis.

METHODS

Administrative decision about staffing patterns hinge on three factors: the complexity of nursing care requirements of patients, the quality of care desired, and the containment of health care costs.[10]

The main reason patients require hospitalization is to receive skilled nursing care.[11]

We performed a systematic review of the literature regarding the effects of nurse staffing levels on patient care, employee, and institutional outcomes. Here, we describe how the search was conducted, how articles were selected, and what data were abstracted for analysis.

Recruitment of Technical Experts

From names suggested by project staff, we assembled the five-member NERAC (Appendix 1: Table A). We sought to represent nurses working in urban and rural areas; in small and large hospitals, and in line and management positions. The NERAC provided ideas, suggestions, and feedback for the design and conduct of the review and commented on the results.

Study Questions

Project staff, in conjunction with DHS and the NERAC, identified four general questions to be addressed in the review:

1. Are variations in nurse staffing levels associated with differences in patient outcomes, such as mortality, falls, pressure ulcers, and the like?

2. Are variations in nurse staffing levels associated with differences in outcomes related to nurses in their role as employees, such as retention, job-related stress, or injuries?

3. Are variations in nurse staffing levels associated with differences in institutional outcomes, such as labor or viability?

4. Is there evidence to justify setting specific nurse-to-patient ratios for nursing units in acute care hospitals?

Literature Search

We searched the literature for studies reporting original research published since 1980 in which some measure of nurse staffing was studied. Most often, this measure was total hours of nursing care, a nurse-to-patient ratio, or a measure of skill mix, such as the percent of patient care hours delivered by RNs. To augment the literature review, we also searched for position statements from professional organizations that had addressed nurse staffing.

The following databases were searched: MEDLINE, CINAHL, the Web of Science, and ABI/Inform. Editorials, news items, and other non-research-based document types were excluded from the search. The electronic searches were performed by a masters-level medical librarian, who is a former RN with 15 years of experience as a reference librarian.

Preliminary searches were conducted to determine the scope and nature of the literature on the topic of nurse staffing levels. These preliminary searches were presented to the NERAC to assist it in evaluating the above research questions. After input from the NERAC, a comprehensive search strategy was implemented (Appendix 1: Table B), and the results were downloaded into the ProCite for Windows v 5.0 (ISI ResearchSoft) software program.

Other relevant articles were identified in hand searches of the reference lists in the retrieved articles and reports. After these articles were added to the reference management database, duplicate entries were eliminated.

Article Selection

The titles and abstracts of articles identified by the electronic search were printed and screened by two abstractors for possible retrieval. Articles were selected for retrieval if the title or abstract referenced any of the following (or related) patient, employee, or institutional outcomes of interest:

.2.1 Patient Outcomes

- nosocomial infections (pneumonia, urinary tract infections)
- patient safety (falls)
- skin integrity (pressure ulcers)
- mortality
- morbidity
- procedural or treatment errors
- medication errors
- patient satisfaction

• length of hospital stay
• readmission rates

.3.1 Nursing Outcomes

• retention rates (turnover)
• job-related stress (burnout, fatigue)
• Job-related injuries (back injuries; needlesticks)
• workplace violence toward nurses
• job satisfaction
• patient monitoring and documentation

.4.1 Institutional Outcomes

• labor utilization and costs
• patient care costs

Articles identified by either of the abstractors were entered into the reference management database and retrieved.

Articles identified from the hand searches were retrieved if 1) the text in which it was cited indicated that the article might be related to some aspect of nurse staffing, or 2) if the title or abstract of the article mentioned some measure of nurse staffing level or skill mix. Unlike the electronic search, articles encountered in the hand search that mentioned only patient, employee, or institutional outcomes were not retrieved unless reference was also made to nurse staffing levels.

In all searches, studies of intensive care units, nursing homes, skilled nursing facilities, or long-term care facilities were excluded. Studies done in countries other than the US were not retrieved. Studies selected for retrieval were identified as such in the database and were then retrieved for possible abstraction.

Data Abstraction

Retrieved articles were reviewed for four eligibility criteria. To be included in the analysis, the research must have:

1. Described the methods of data collection.
2. Been conducted in the United States since 1980.
3. Been conducted in acute care, rehabilitation, or psychiatric hospitals.
4. Assessed the relationship between some measure of nurse staffing and one or more patient, employee, or institutional outcomes.

Articles reporting research meeting these criteria were abstracted and graded as described below. Abstracted data were recorded on a standard form (Appendix 1: Abstraction Form) by one of two abstractors. Both abstractors and one or two other project staff reviewed all

abstracted articles to confirm that the inclusion criteria were met and that the data had been abstracted accurately and completely. Differences were resolved by group discussion.

Internal validity

In addition to the data abstracted from each article, we evaluated the internal and external validity of each study. Internal validity is the degree to which the study likely measured what it intended to measure. We graded each study on three scales to provide a rough measure of internal validity:

- study design (2 = prospective; 1 = retrospective; 0 = cross-sectional)
- unit of reporting (2 = each unit; 1 = class of unit; 0 = larger grouping)
- potential for bias (2 = low; 1 = moderate; 0 = high)

Prospective studies (cohort or randomized trials) were those in which data were collected to answer a specific research question posed before the data were collected. Retrospective studies (case-control and analyses of large databases) were those in which data were collected for other reasons and before the research question was posed. Cross-sectional studies were descriptive surveys of a single time period.

Unit of reporting is a rough measure of how the results were aggregated when reported. Of most interest were results reported for each nursing unit studied because these results are directly applicable to the problem at hand. Of less interest were results reported by class of nursing unit studied, in which results from, say, all med-surg nursing units were combined. Of least interest were results aggregated at levels above the class of nursing unit, such as those reported by hospital, group of hospitals, or even by state.

Potential bias was graded as 1 (moderate) unless the presence or absence of a design or analytic feature seemed to make the study more or less subject to bias. Such features were recorded in a "notes" data field on the abstraction form. We recognize the difficulties in accurately assessing bias in these studies but felt compelled to identify studies that were especially methodologically strong or weak.

External validity

External validity is the degree to which the results of the study could be applied to other settings. Again, each study was graded on three scales:

- The date the data were collected (2 = 1995 or later; 1 = 1990-94; 0 = 1989 or before). In the evidence tables, these dates are referred to as the "age of data."
- The number of hospitals studied (2 = 10 or more; 1 = 2 to 9; 0 = 1).

- The number of nursing units studied (2 = 10 or more; 1 = 4 to 9; 0 = 1 to 3).

The three periods of data collection were chosen to reflect the growth of managed care. Thus, studies conducted before 1990 were deemed to predate many of the changes that accompanied managed care. Those between 1990 and 1995 should reflect the early stages of managed care, and studies in the past 6 years should reflect the most recent practices.

The number of hospitals and nursing units (and in some cases, the number of nurses or the number of patients) in the study constituted the sample size.

We report the results of each study along with the grades of the six scales for internal and external validity for the study itself. This format allows each result to be interpreted in light of the study's characteristics. Because the numerical results were often difficult to interpret, we expressed them in clinical terms. For example, one study reported that a richer skill mix was significantly associated with a decrease in the rate of medication errors. The numerical results were presented as $\beta = -0.53$; $P < 0.05$, where β is a regression coefficient and P is the probability that a coefficient as large or larger as the one observed (-0.53) would have occurred by chance if there were, in fact, no relationship between skill mix and the rate of medication errors. We expressed the data reported in standard Roman type, and the extrapolation or interpretation of the data in bold type:

> Example: Each 1% increase in RN skill-mix was associated with a decrease of one-half of a medication error for every 10,000 doses administered ($\beta = -0.53$; $P < 0.05$). **An increase of about 2% in RN staffing mix would be required to prevent 1 additional medication error in every 10,000 doses administered.**

Expressing the results in this way requires two assumptions, both of which are easily violated. The first assumption is that the reported relationship was, in fact, linear. Studies using linear regression analysis, in general, did not report whether the assumption of linearity was met. In the two studies that *did* test for linearity (both studies by Blegen et al.), the relationships were not linear. The second assumption, made when extrapolating the results into clinically interpretable terms, is that the results could be extended beyond the range of data collected in the study. For example, as a general rule, we looked at the presumed effect of enriching RN skill mix by 10% to help determine whether the extrapolated results might be clinically important. If the range of skill mixes studied was less than 10%, this assumption could easily be violated.

Clinical and Statistical Grades

Three members of the project staff, an RN, an MD, and a specialist in reporting biomedical research, independently graded the clinical importance of each finding as shown below. Differences were resolved in discussion.

Clinical grades are as follows:

> **0** = The finding was not considered to be clinically important, usually because it was small, inconsistent, or required excessive resources to achieve.

? = The finding may or may not be clinically important, depending on the range of severity of the outcome.

1 = The finding was considered to be clinically important.

We fully recognize that the clinical grades are subjective and involve trade-offs between clinical inputs (staffing) and outputs (usually adverse events) that may be valued differently by different groups. We tried to be reasonable in our gradings, but people may interpret the findings differently. The authors of the reviewed articles, who faced these same concerns, usually ignored them and relied solely on the results of significance testing when interpreting their results.

Statistical significance was graded as follows:

0 = The P value was greater than 0.05, was not reported, or the results were described as not being statistically significant.

1 = The P value was less than 0.05 or the results were described as being statistically significant.

Description of Evidence Tables

Abstracted data were sorted into three types of evidence tables for analysis. The first type lists the research questions and response variables used in the studies reviewed. The second type summarizes the organizational units investigated. The third type summarizes the results of each study and presents the grades for internal and external validity and the effect score. All tables and the analysis were then presented to the NERAC for evaluation and comments.

RESULTS OF THE LITERATURE SEARCH

. . . like medical care, [nursing care] is subject to practice variations . . .[12]

The amount of time spent by a nurse with a patient to provide quality care. . . is more than the sum of its parts.[13]

The literature searches identified 2870 articles of potential interest. Of these, 458 were selected for retrieval by at least one abstractor. Of the articles selected for retrieval, 456 (99.5%) were obtained. Of the retrieved articles, 419 were rejected for not meeting the inclusion criteria or for not reporting key information, leaving 37 articles for analysis. Of these, 6 were published between 1980 and 1985; 7 between 1986 and 1990; 13 between 1991 and 1995; and 11 since 1996. These 37 articles reported 266 individual findings, each of which is described in the evidence tables cited here.

Questions Addressed in the Literature (Table 1)

Researchers have asked a variety of questions about the effect of nurse staffing on the delivery of medical care (Table 1). Most studies used as an explanatory variable a measure of either total nursing staff, consisting of all or some combinations of registered nurses (RNs), licensed vocational or practical nurses (LVNs or LPNs), and unlicensed assistive personnel (UAP), or of "skill mix," generally the proportion of the nursing staff that consisted of registered nurses. About a third of the studies analyzed data from state or national databases.

Organizational Units and Characteristics Studied (Table 2)

Research has been conducted at all organizational levels using a variety of endpoints (Table 2). For our purposes, studies reporting data at the level of the nursing unit were of most interest. Data aggregated by hospital generally include all nursing units, including intensive-care units, whose higher mortality, higher staffing levels, and richer skill mix and make the results more difficult to interpret. About half the studies reported data at the hospital level, and half reported it at the nursing unit level. The few remaining studies were of individual nurses or patients, rather than of organizational units.

Results By Study Question

The results for each of the four study questions are presented in evidence Tables 3 through 19 and are summarized in Table 20. In the evidence tables, studies of total nurse staffing and of skill mix are presented together. Ellipses (. . .) indicate data that were not reported. Data abstracted from the original articles are presented in standard Roman type. The extrapolated and interpreted findings are presented in boldface type. The number at the end of each finding is the page number of the original article from which the data were abstracted. In some cases, the results were counter intuitive, as when a marked increase in RN staffing was associated with an *increase* in error rates, or when a marked decrease in RN staffing had no effect on error rates. We indicated such findings by enclosing the clinical grade in parentheses.

Question 1. Are variations in nurse staffing levels associated with differences in patient outcomes?

.1.1.1 Effects of Nurse Staffing on Unspecified Nosocomial Infections (Table 3)

The 6 studies that examined the effect of nurse staffing on unspecified nosocomial infection rates reported 10 findings, 3 of which were clinically and statistically significant (Table 3). The ANA study [1997] found statistically significant relationships between skill mix and postoperative infection rates among more than 300 California hospitals in 1992 and 1994, but not among more than 125 New York hospitals during the same years. Halley [1982] found that understaffing on a neonatal intermediate care unit was strongly associated with the incidence of staphylococcal infection rates.

The one prospective study, by Shukla [1983], found that nursing skill mix had no effect on postoperative infection rates. Taunton [1994] reported that absenteeism was statistically associated with increased infection rates, but the results were not consistent over time or among hospitals. Finally, Grillo-Peck [1995] found that reducing skill mix from 80% RN to 60% RN had no effect on infection rates.

.1.2.1 Effects of Nurse Staffing on Urinary Tract Infections (Table 4)

.1.3.1

Four studies investigated the effect of nurse staffing on urinary tract infection (UTI) rates (Table 4). Of the 16 results, 10 were statistically significant. The ANA study [1997] found a relationship in California hospitals for both 1992 and 1994, and for New York hospitals only in 1994. Needleman [2001] reported a relationship between skill mix and infection rates in medical, but not in surgical patients.

Sovie [2000], in a large and rigorous study, found that total nursing hours per patient day was associated with a decrease in UTI rates. This finding was present only in 1997 data, however, not in 1998 data, and the clinical importance of the effect could not be assessed. Kovner [1998] found that a higher number of RN FTEs/patient day was statistically associated with lower rates, but the clinical importance of the lower rates we judged to be marginal.

.1.4.1 Effects of Nurse Staffing on Rates of Pneumonia (Table 5)

All three of the studies using pneumonia as an outcome reported clinically important and statistically significant results (Table 5). The ANA [1997] study found a relationship with skill mix in California hospitals, but not in New York hospitals; Needleman [2001] found a relationship with skill mix on both medical and surgical units; and Kovner [1998] found a relationship between the number of RNs/patient day in patients after surgery but not after invasive vascular procedures.

.1.5.1 Effects of Nurse Staffing on Patient Falls (Table 6)

.1.6.1

Of the 10 studies investigating patient falls, 3 reported relationships with nurse staffing characteristics (Table 6). Blegen [1998B], in a study of 39 nursing units from 11 hospitals, found that fall rates were lower in units with richer skill mixes. Paradoxically, Grillo-Peck [1995] reported that reducing the skill mix of 80% RN

to 60% RN, while increasing the total number of care givers, resulted in a drop in fall rates among 71 patients on a neuroscience unit.

Sovie [2000] found that RN hours worked per patient day was statistically associated with fall rates on medical and surgical units in 1997, but the associations were gone in 1998. Fall rates decreased when total hours of nursing care increased, but the change was not statistically significant.

In one nursing unit, Kustaborder [1985] found that the rate of falls per admission increased as the number of patients assigned to one nurse increased from 15 to 18. No change in rate was found after coordinating break schedules to keep staff available on the floor. Arbesman [1999] reported that the ratio of actual to expected nurse-staffing levels was no different for 252 seniors who fell in the hospital than in 250 controls matched for sex, age, and time since hospital admission. Nurse absenteeism was not related to patient falls in either Ceria's or Taunton's studies.

.1.7.1 Effects of Nurse Staffing on Pressure Ulcers (Table 7)

Despite the attention paid to pressure ulcers as a potential indicator of nursing quality, only 4 studies included it as an endpoint (Table 7). The 1997 ANA report found that richer skill mixes were associated with lower pressure ulcer rates in California and New York hospitals in 1992 and 1994. Total nursing hours was associated with lower rates in New York in 1992 but not in 1994, and in California in 1994, but not in 1992. Blegen [1998A] also found that a richer skill mix, up to 88% RN, was associated with lower rates in 42 nursing units from one hospital.

.1.8.1 Effects of Nurse Staffing on In-hospital Mortality (Table 8)

The effect of nurse staffing on in-hospital mortality was reported in 11 studies, 4 of which found a significant relationship (Table 8). Manheim found that more RNs per admission and a richer skill mix were each associated with lower mortality rates in 3,796 hospitals in 1992. (This effect was 10 times larger than the other findings of the study, however, which makes us wonder if the result is reported correctly.) Hartz [1989] also reported that more RNs and a richer RN skill mix were associated with lower mortality among 3100 hospitals (the data are from 1986). Krakauer and colleagues compared two predictive models constructed from different data sets: one based on HCFA (Healthcare Finance Administration) claims data and another based on clinical data collected specifically to validate the claims. Both models support an inverse relationship between a richer RN skill mix and in-hospital mortality. Finally, Aiken [2000] reported a similar relationship in 22 hospitals known for quality of nursing care

("magnet hospitals") but not in 314 nonfederal hospitals. All of these studies used data aggregated at the hospital level.

Blegen [1998A], the one study not aggregating data from large numbers of hospitals, reported that each additional percentage of RNs in the skill mix, above 88%, was associated with a statistically significant increase of 0.3 deaths/1,000 patient days. While each additional percentage increase in the number of RNs in the skill mix up to 88%, was associated with a decrease in mortality.

.1.9.1 Effects of Nurse Staffing on Hospital Length of Stay (LOS) (Table 9)

Six studies compared nursing staff characteristics to hospital length of stay (Table 9). Once again, Sovie [2000] found significant relationships in 1998 data but not in their 1997 data. The ANA study likewise found conflicting results between its 1992 and 1994 data. Higher total nursing hours and richer RN skill mixes were significantly related to decreases in LOS in California and New York hospitals for both periods and for Massachusetts hospitals in 1994. Shamian [1994] also found that LOS was lower when total hours worked per patient day was higher on 9 different services.

Statistical relationships were reported by Sovie [2000] and the ANA [1997], but the decreases in LOS were not considered to be clinically important.

Flood [1988], who compared a chronically understaffed unit with an adequately staffed one, found that the adequately staffed unit had a 1.3-day lower LOS and 9% fewer patients with LOS's above the hospital mean, although neither difference was statistically significant. Grillo-Peck reported a 0.7-day decrease in LOS in one nursing unit after the change from 80% to 60% RN skill mix. The difference was not statistically significant.

.1.10.1 Effects of Nurse Staffing on Testing, Treatment, and Procedure Errors (Table 10)

Only 2 of the 6 studies using testing, treatment, or procedure errors, such as errors in adminstering medications, as outcomes reported a relationship with nurse staffing (Table 10). In both of the studies reported by Blegan in 1998 [A & B], a curvilinear relationship was indentified. An increase in the RN skill mix up to 88% (A) or 85% (B) was associated with a decrease in the rate of medication errors/10,000 doses, while a skill mix greater than 88% (A) or 85% (B) was associated with an increase in medication errors.

.1.11.1 Effects of Nurse Staffing on Complications Other Than Infections (Table 11)

Several studies used patient complications as an outcome variable (Table 11). Behner et al. found a significant, inverse relationship between nurse staffing levels and complication rates in the first 3 days of hospitalization among 132 surgical patients on one nursing unit. Data were not reported, however. Needleman [2001] reported clinical and statistical inverse relationships between total nursing hours and shock in medical patients; between total nursing hours and the rates of gastrointestinal hemorrhage in medical patients; and between total nursing hours and total RN hours in rates of "failure to rescue" (death after complications) in surgical patients. In a study of 506 hospitals, Kovner [1993] reported statistically significant inverse relationships between RN FTEs and non RN FTE and rates of venous thrombosis among patients after major surgery. The clinical importance of this relationship could not be determined, however.

.1.12.1 Effects of Nurse Staffing on Patient Satisfaction (Table 12)

.1.13.1

Moving from a team model of nursing to an all RN-model was statistically associated with less satisfaction of care in Shukla's 1983 study (a drop from 69 to 57 points on a 100-point scale). Higher nurse staffing was statistically related to greater patient satisfaction with care in studies by Dobal [1995], Sovie [2000], and Hinshaw [19981], although the effect sizes were not remarkable. Skill mix explained 38% of the variation in patient satisfaction with pain management on medical units in Sovie's 1997 data but not in the 1998 data. Hinshaw [1981], using 1976 data, found that patients trusted their nurses more when all-RN staffing replaced a team staffing model. The difference was a half-point on a 5-point Likert scale. Finally, in a survey by Dobal of 442 care providers, including nurses, nurse-to-patient ratios explained 18.5% of the variation in nurses' perception of being able to meet the families' needs and 9% of the variation in nurses' perception of the quality of their own supporting care.

Question 2. Are variations in nurse staffing levels associated with differences in employee outcomes?

.1.14.1 Effects of Nurse Staffing on Patient Care Monitoring (Table 13)

In a well designed, 7-year study done in the late 70s and early 80s, Carter and colleagues [1986] found that a richer skill mix was associated with 1) better quality nursing care plans, 2) better documentation of nursing care, and 3) better nursing care (Table 13). These results reflect significant relationships between skill mix and three indices, each consisting of the percentage of affirmative

responses given by trained raters to the number of questions comprising the index. The clinical implications of changes in the indices are not discussed.

The other investigator to consider patient care monitoring, Ceria, reported preliminary results of a larger study that does not appear to have been published. No data or even operational definitions of variables ("nurse absenteeism," "care plan monitoring") are included in the short preliminary report, although all results were said to be not statistically significant.

.1.15.1 Effects of Nurse Staffing on Nurse Documentation (Table 14)

In a 1976 study published in 1981, Hinshaw observed that changing from a team model of nursing to an all-RN model was accompanied by an increase in the number of documented patient problems (Table 14). Kuhn [1991] studied 1,219 hospitals and found that richer skill mix was statistically associated with lower physician-confirmed problem rates in quality of care reviews in California, New York, Pennsylvania, Illinois, and Texas, but not in Ohio.

.1.16.1 Effects of Nurse Staffing on Nurse Absenteeism, Turnover, and Vacancy Rates (Table 15)

Richer nurse-to-patient ratios and higher ratios of nurses to hospital beds were directly associated with higher rates of turnover, according to Bloom et al. (Table 15). The authors interpreted this result to mean that RNs had more upward mobility in those hospitals with higher nurse-to-patient ratios, not that dissatisfaction with the nursing model was associated with resignations.

.1.17.1 Effects of Nurse Staffing on Nurse Satisfaction (Table 16)

Only one older study, Hinshaw [1981], tested for a relationship between nurse staffing and job satisfaction. Self-report measures of both job satisfaction and group cohesion were statistically associated with the change to 100% RN staffing on the one nursing unit studied (Table 16). Both endpoints were evaluated on a 5-point Likert scale, making the differences difficult to interpret.

.1.18.1

.1.19.1 Effects of Nurse Staffing on Other Aspects of Nursing (Table 17)

In addition to Hinshaw's 1981 finding that definitions of nursing became "more professional" with an all-RN staff, Lanza concluded that assault rates on six psychiatric units were not related to the number of patients, RNs, LPNs, UAPs, or total staff (Table 17).

Question 3. Are variations in nurse staffing levels associated with differences in institutional outcomes?

.1.20.1 Effects of Nurse Staffing on Amount of Direct Nursing Care (Table 18)

Arndt [1998] found that increasing the proportion of care delivered by RNs (a richer RN skill mix) was statistically associated with a 12-minute per day increase in the amount of care received by patients undergoing nonradical hysterectomy and with a 9-minute per day decrease in the amount of care received by patients undergoing femoral hernia operations (Table 18).

.1.21.1 Effects of Nurse Staffing on Institutional Financial Outcomes (Table 19)

Of the 9 studies on financial outcomes, 6 reported financially important, but not statistically significant, relationships (Table 19). Hinshaw [1981], Bostrom [1993], Behner [1990], Flood [1988], Halloran [1983], and Osinski [1980] all reported that enriching RN skill mix or adding more RNs to the staff were cost-effective strategies. All of these studies predate the introduction of managed care, however. In a more recent study, Sovie [2000] found no relationship between regional adjusted labor costs per discharge and skill mix.

Basing costs on a standardized patient, Glandon [1989] concluded that richer skill mixes were more expensive than leaner ones.

Question 4. Is there evidence to justify setting specific nurse-to-patient ratios for nursing units in acute care hospitals?

None of the studies reviewed were designed specifically to compare nursing units using nurse-to-patient ratios as explanatory variables. Virtually all studies adjusted for patient acuity, and most also adjusted for nursing skill mix. Thus, we found no evidence to justify specific nurse-to-patient ratios in acute care hospitals, especially ratios that are not adjusted for case mix and skill mix.

Summary of the Evidence

All 266 findings from the 37 studies are summarized in Table 20.

- The strongest evidence for a relationship between nurse staffing and patient outcomes is between RN skill mix and hospital mortality. Of 11 studies testing this relationship, 4 found results that were both clinically and statistically important, with 10 of 28 findings indicating a statistically significant relationship.

- All 3 studies testing the relationship between nurse staffing levels and the rates of pneumonia likewise reported clinically and statistically important relationships, and 8 of 11 findings were statistically significant.

- An inverse relationship between nurse staffing and length of stay was found in 3 of 6 studies using hospital length of stay as an endpoint.

- Clinically and statistically important relationships were reported by between nurse staffing and rates of nosocomial infections (4 of 10 findings were statistically significant), rates of urinary tract infections (10 of 16 findings were statistically significant), rates of pressure ulcers (8 of 19 findings were statistically significant), and nursing documentation (6 of 10 findings were statistically significant). Each of these relationships was reported by 2 studies.

- Of 9 studies on the financial implications of more or richer RN staffing, 2 found no relationship (more or richer RN staffing did not increase costs) and 6 found cost savings, although none of the 8 findings were statistically significant.

DISCUSSION

One of the principal features of any system is that its performance is determined as much by the arrangement of its parts—their relations and interactions—as by the performance of the individual components.[14]

Nursing care is a key factor in the outcomes of hospitalized patients, but patient outcomes are also affected by care from other disciplines, the severity and complexity of the patient's condition, other characteristics of the patient, and the work environment.[15]

Summary of the Results

Although limited, there is a growing body of evidence showing a relationship between nurse staffing levels and patient, employee, and organizational outcomes. While not compelling, the evidence does suggest probable inverse relationships between:

1) The number of RNs, and to a lesser extent, RN skill mix, and hospital mortality.

2) The number of RNs and, to a lesser extent, RN hours worked per patient day, and rates of pneumonia.

3) Total nursing hours worked per patient day and, to a lesser extent, RN skill mix, and hospital length of stay.

In addition, the evidence suggests statistical, if not clinical, relationships between nurse staffing and rates of nosocomial infections, urinary tract infections, pressure ulcers, and identification of patient problems.

Increasing the number of RNs or enriching the RN skill mix does not appear to increase costs and may even reduce costs when the expenses of adverse patient outcomes are considered.

Finally, none of the reviewed studies compared the effects of specific nurse-to-patient ratios. Almost all the studies included in the analysis adjusted their analyses for both the case mix of the patients (severity of illness) and the skill mix of the nursing staff (the ratio of RNs to other nursing personnel). Thus, the literature offers no support for establishing minimum nurse-to-patient ratios for nursing units in acute care hospitals, especially in the absence of adjustments for case mix and skill mix.

Characteristics of the Literature

None of the 37 studies reviewed directly and systematically compared specific nurse-to-patient ratios. About half of the studies (19 of 37) used hospital-level data, rather than nursing-unit-level data. This aggregation confounds the interpretation of these studies because they include data from intensive-care units, which have different staffing needs and different patient characteristics. However, when Needleman et al. [16] compared data from nursing units in California to hospital-level data throughout the country, they found no appreciable differences in the results. They looked only at statistically significant results, in the predicted direction, which were consistent across 10 regression models. In contrast, we found that only 9 of 62 findings (15%) graded as both clinically and statistically significant were from studies reporting nursing-unit-level data, and only 18 of 153 (12%) statistically significant findings came from such studies.

With the exception of satisfaction with nursing services, all patient outcomes studied were adverse events. Positive outcomes are thus conspicuous by their absence and may be a new area for research.[17] In addition, all outcomes studied were events that occurred during the hospital stay. Verran [18] has suggested that the effects of quality nursing care may not appear until after discharge. If so, such effects may include more positive outcomes, such as major changes in lifestyle or changes in specific health behaviors. Assessing the effects of nursing care after discharge may also be a fruitful area of research.

The following methodological and analytical problems [19] are abundant in the articles reviewed:

- Statistical significance was often confused with clinical importance. The relative absence of confidence intervals contributes to this problem by focusing attention on P values and not on the differences or changes they represent. Often, small or even trivial differences were cited as evidence in support of a relationship on the sole basis of a statistically significant P value.

- The assumptions of statistical tests often appear to have been violated, such as when parametric tests were applied to markedly non-normally distributed data (such as analyzing apparently untransformed length-of-stay data with ANOVA) or when linear regression analysis is applied with no assurance that the data actually showed linear relationships. Many results are presented as regression coefficients, but few studies reported analysis of residuals that would have confirmed linearity.

- Rarely did authors report whether or not they had controlled for multiple comparisons, a process that increases the probability of making type-I errors. Many studies had multiple response variables, multiple explanatory variables, multiple subgroup analyses, or data collected at multiple time points, all of which are subject to the multiple comparisons problem. Statistical corrections for this problem were rarely mentioned in the articles.

- Positive conclusions were often drawn when any subgroup analysis showed a relationship between higher nurse staffing and improved patient outcomes. This problem was especially noticeable when the study considered several explanatory and response variables. One study, for example, reported only 7 of the 120 relationships possible when comparing 3 staffing variables with 5 patient outcomes for 2 types of nursing units, for two levels of aggregation above the nursing level, for each of 2 years.

- Results expressed as regression and correlation coefficients were rarely interpreted for their clinical importance. Instead, the results were usually judged to be positive or negative on the basis of P values alone. We imposed such interpretations on the reported results in the interest of rendering them comprehensible but may have done so in violation of the assumptions of the analysis; namely, that the relationships were linear and that the results were sometimes extrapolated beyond the range of the collected data.

Types of Nursing Shortages

Prescott and colleagues [20] identified four situations in which nurses "work short"; that is, work on understaffed nursing units. A vacancy shortage is caused by not being able to fill an existing position. This type of understaffing is influenced by the supply of nurses, as well as by institutional inducements to attract and retain nurses. One potential consequence of AB 394 may be to increase the number of nursing positions beyond the short-term supply of nurses, resulting in vacancy shortages.

A transient shortage is caused by unplanned absences that create unpredictable but short-term understaffing. Two, less obvious, circumstances can lead to transient shortages: the addition of new nursing graduates to a unit and the temporary assignment of a "float" nurse whose clinical expertise does not match the needs of the unit. AB 394 does not address these two circumstances because the bill does not incorporate skill mix into the mandated staffing requirement.

A scheduling shortage is created when too few nurses are scheduled to work during certain periods, such as weekends and holidays, when a hospital's census is expected to be reduced. Scheduling shortages are compounded if nurses must perform tasks usually done by others, such as patient transportation, social services, or housekeeping. A case in point: some hospitals receive up to 80% of their admissions from the emergency department (ED). (In California hospitals, 34% of all admissions statewide come from the ED.) [21] Variations in time of day and day of week require unscheduled staffing.[22] Again, scheduling shortages are not directly addressed by AB 394.

A position shortage is created when too few positions or inappropriate positions (resulting in an inadequate skill mix) are allocated to a unit. Such shortages are usually associated with fiscal constraints. Position shortages are planned and predictable and are directly addressed by AB 394.

The patient outcomes studied in the literature have their basis in the fact that "When nurses work short, they change the way they do their jobs."[20] In particular, nurses may make four types of changes:

1. Patient care needs will be prioritized differently, with critical needs such as assessments and administration of medications will taking precedence over psychosocial or educational needs. This leads to a reduction in emotional, social, and instructional support for the patient.

2. There may be an increase in the number and seriousness of errors as well as a decrease in the ability to identify errors.

3. The care they provide may lack continuity. Nurses have less time to develop rapport with their patients and therefore cannot follow them as closely or anticipate their needs as well.

4. Insufficient staffing may lead to inappropriate resource use. Transfers to or from the intensive care unit may be accelerated or delayed. For example, a patient may be moved out of the ICU a day early in order to make room for a more critically ill patient, or a patient may be held in the ICU longer than necessary because there is not adequate staffing on the medical-surgical units.

Discussion of Study Questions

Question 1. Are variations in nurse staffing levels associated with differences in patient outcomes?

Effects of Nurse Staffing on Nosocomial Infections

The most common infections acquired by patients in the hospital are those of the urinary tract, surgical wounds, bloodstream, and respiratory system (pneumonia).[24] In fact, the evidence evaluated here suggests that rates of nosocomial infections, especially pneumonia and urinary tract infections, are affected by nurse staffing levels.

Effects of Nurse Staffing on Patient Falls

We found no evidence linking nurse staffing variables to patient falls, despite the conclusion of Reed et al.[17] that falls are more likely to reflect the quality of nursing care than patient acuity.

Effects of Nurse Staffing on Pressure Ulcers

Two studies reported some evidence of a relationship between nurse staffing variables and the incidence of pressure ulcers in acute care hospitals. The 1997 ANA study reported clinically and statistically important findings

between skill mix and ulcer rates for California and New York hospitals in 1992 and in 1994. Total nursing hours was associated with ulcer rates in California in 1994 but not 1992, and in New York in 1992 but not 1994. Blegen (1998A) also found a relationship between ulcer rates and skill mix but not total nursing hours.

Reed and colleagues [17] concluded that pressure ulcers were more likely to reflect patient acuity than the quality of nursing care.

Effects of Nurse Staffing on In-hospital Mortality

More studies (4 of 11) reported an inverse relationship between nurse staffing and in-hospital mortality than with any other outcome. In addition, 10 of the 28 findings indicated a statistical relationship between these two variables. Although this relationship may be one of cause and effect, it may also be the result of other health care trends. For example, in the past decade, the number of nurses has been declining and the acuity of hospitalized patients (and therefore the risk of death) has been increasing, both in response to cost containment efforts. Thus, it is possible that mortality is more likely to reflect patient acuity than the level of nurse staffing. [17]

Effects of Nurse Staffing on Hospital Length of Stay

The possible relationship between nurse staffing levels and hospital LOS suggested by the data is difficult to interpret. Some authors [24] interpret a direct association between staffing levels and LOS as being expected, because sicker patients have longer stays and therefore require and receive more nursing care. Others [25,26] interpret an inverse association as evidence that better nursing care reduces LOS. In addition, the introduction of critical paths and prospective payment may result in the maximum stay being specified at the time of admission [18], which, even if not always the case, would undoubtedly reduce the variability of hospital stays and, hence, its usefulness as a sensitive measure of nursing care.

Personal care and psychological support are an integral part of professional nursing practice.[27,28] At least in the past, psychosocial care directed to the personal, emotional, and existential needs of the patient has been associated with reduced LOS. In a meta-analysis of 13 studies of psychosocial interventions using hospital days after surgery or heart attack as outcomes, Mumford and colleagues [25] reported that psychological interventions reduced hospital LOS from an average of 10 days in the control group to about 8 in the treatment groups, a reduction of 19%. In another meta-analysis of 33 studies, including 9 from the Mumford review, Devine and Cook [26] found an average decrease in LOS of 1.3 days, or about a 12% reduction. Whether these reductions can be achieved in the current decade is unknown, but they do indicate a relationship between nursing care hours and patient outcomes. Hogan and Rohrer [29] also concluded that psychosocial nursing care in nursing home patients was associated with modest cost reductions.

Mumford et al. note that: "It is often argued that the medical care system cannot afford to take on the emotional status of the patient as its responsibility. Time is short and costs are high. However, it may be that medicine cannot afford to ignore the patient's emotional status, assuming that it will take care of itself. Anxiety and depression do not go away by being ignored."[25]

Although not directly related to nurse staffing levels, some studies have found that discharge planning by nurses can safely reduce hospital LOS. In an analysis of 500 representative patients discharged from an acute care hospital in 1983, Marchette and Holloman [30] found that for each area of discharge planning performed by a nurse (nutrition, medication, activity, and so on), hospital stay decreased by an average of 0.8 days. Further, every day that a patient's discharge planning was postponed resulted in an additional 0.8-day increase in LOS.

Brooten and colleagues [31] reported that appropriate discharge planning and follow-up home nursing visits for very-low-birth-weight infants reduced length of stay by an average of 11 days (47 vs 58 days) and mean hospital charges by 26% ($48,000 vs $65,000). Neidlinger et al. [32] found that comprehensive discharge planning by a clinical nurse specialist was cost-effective for hospitalized geriatric patients. (Mean hospital costs for the intervention group were $3,100; mean costs for the control group were $4,400. P = 0.036 for the difference, $1,311). Again, these reductions may not be possible in the current decade, but they do show that discharge planning is a cost-effective use of nurses' time. Finally, Naylor and colleagues [33] reported that comprehensive discharge planning delayed or prevented hospital readmission among elderly medical and surgical patients, especially in the first 6 weeks after discharge. However, unplanned readmissions to the hospital are usually interpreted to mean that patients were discharged prematurely, a supposition that may or may not be true.[23]

Effects of Nurse Staffing on Testing and Treatment Errors

One of the most studied treatment errors is that of medication delivery errors: wrong patient, wrong drug, wrong dose, wrong route, or wrong time.[18] Reed and colleagues [17] in a correlational study, concluded that medication errors were more likely to reflect the quality of nursing care than patient acuity. Further, Blegen found that skill mix up to approximately 85% RNs was associated with a decrease in medication errors.

Effects of Nurse Staffing on Other Complications

In the second ANA report, Nurse Staffing and Patient Outcomes,[34] which we did not abstract for this review, Lichtig and colleagues also explored relationships between nurse staffing characteristics and 12 other complications:

adverse drug reactions	anoxic brain damage
communicable conditions	post-partum complications
diabetic complications	joint effusion
metabolic imbalances	personal care complications
secondary psychiatric diagnoses	transfusion reactions

trauma in non-trauma patients vascular complications

None of these complications was statistically related to nurse staffing levels, and the results differed across different data sets (MEDPAR, HCFA, various state databases).

Needleman et al. [16] found no associations among medical or surgical patients between either RN hours/day or total nursing hours/day and the rates of deep vein thrombosis, central nervous system complications, sepsis, wound infections, pulmonary failure, and metabolic derangement. They did find an association between total nursing hours per day and total RN hours per day and shock in medical patients.

Although back pain and needlestick injuries were referenced as being related to nurse staffing levels, we found no study that used these outcomes.[35]

Effects of Nurse Staffing on Patient Satisfaction and Perceptions of Care

Although 4 of 6 studies reported at least a statistical relationship between nurse staffing and measures of patient satisfaction, the findings are not persuasive. In a study of AIDS units, Aiken and colleagues [36] found that nurse control over the practice setting explained almost all of the variation in patient satisfaction that was associated with different organizational forms of AIDS care. In other words, nursing competence, rather than nursing numbers, is likely what affects patient satisfaction. In addition, patient complaints may more likely to reflect patient acuity than the quality of nursing care.[17]

A finding from a Gallop poll indirectly related to patient satisfaction—and subject to considerable bias in the nature of the question—is that 84% of American adults surveyed preferred a nurse-to-patient ratio of 1 to 4 over a ratio of 1 to 6.[37] A survey of nurses perceptions of health care in US hospitals, found that 69% believed that patients were not receiving adequate care. In addition, 66% of respondents believed that staffing levels were inadequate where they worked, and 75% were concerned that short staffing would lead to mistakes in patient care. [38].

Question 2. Are variations in nurse staffing levels associated with differences in employee outcomes?

Effects of Nurse Staffing on Patient Care Monitoring

In a 1986 chapter, Carter et al. [39] report a clinically important and statistically significant relationship between nurse staffing and patient monitoring. Ceria, [40] in a preliminary report not followed by a complete account, did not.

Effects of Nurse Staffing on Nursing Documentation

Nursing documentation is important because problems that are not documented tend not to be treated. Both Kuhn [41] and Hinshaw [42] reported clinically important and statistically significant relationships between nurse staffing and documentation of patient problems. A possible problem in interpretation is whether more nurses simply have the time to document more problems or whether the number of problems they detect is actually greater.

Effects of Nurse Staffing on Absenteeism, Turnover, and Vacancy Rates

Bloom et al. [43] found that RN skill mix was directly related to turnover rates. Their interpretation is that "When nurses work in settings where there is a strong professional culture, their sense of their potential is reinforced, and alternative opportunities available to them are introduced. One might expect that turnover in this situation would be to another position rather than turnover due to family or other personal factors." They also conclude that organizational and working conditions are important factors in voluntary turnover and that these conditions are amenable to administrative interventions.

Duquette et al., [44] in a systematic review, concluded that the evidence supports a direct relationship between heavier workload and burnout. Time spent with patients by itself, however, did not appear to be associated with burnout.

Effects of Nurse Staffing on Nurse Satisfaction

The one study of nurse staffing levels and nurse satisfaction (Hinshaw,1981[42]) found a statistically significant relationship between the move to all-RN staffing and increased job satisfaction among nurses. Satisfaction was measured with a 5-point Likert scale, so the "clinical" importance or implications of the change in scores from a mean of 2.97 to 3.52 could not be determined.

Effects of Nurse Staffing on Other Aspects of Nursing

Lanza [45] studied the factors that might explain patient assaults on staff on psychiatric units. They found no consistent relationships between assault and: number of patients, number of RNs, number of LPNs, number of nursing assistants, total number of staff, or any patient-to-staff ratio.

Question 3. Are variations in nurse staffing levels associated with differences in institutional outcomes?

Effects of Nurse Staffing on Amount of Direct Nursing Care

Neither Shukla (1983)[46] nor Arndt (1998)[47] found that skill mix was substantially related to the amount of direct nursing care provided to patients. That is, more nurses may not translate to more nursing care. Increasing the percentage of RNs in the nursing staff probably has a larger effect on the quality

of patient care than on the quantity of patient care.

Effects of Nurse Staffing on Institutional Financial Outcomes

All but 1 of the 9 studies of financial outcomes of nurse staffing found that better staffing was either cost-neutral or cost-effective. Although none of the individual findings was statistically significant, when taken as a group, these studies indicate that reducing the size or mix of a nursing staff may be "penny-wise but pound-foolish."

Question 4. Is there evidence to justify setting specific nurse-to-patient ratios for nursing units in acute care hospitals?

The fourth research question was "Is there evidence to justify setting specific nurse-to-patient ratios for nursing units in acute-care hospitals?" The answer to this question is "no." Few studies have compared one ratio to another, and these were opportunistic comparisons, not systematic ones. Further, virtually all studies reviewed here adjusted for patient case mix and nursing skill mix, indicating that nurse-to-patient ratios by themselves are not sufficient to assure quality care.

The Importance of Adjusting for Case Mix and Skill Mix

The need to adjust for case-mix when studying nurse staffing levels was recognized in the 1970s, during the development of the diagnosis-related groups, and is well established in the literature.[48]

Kirby [49] asked 216 nurse administrators and nurse managers to rank 10 factors by their affect on the number of nursing hours per patient per day. The factors were: skill mix, size of the nursing unit, case mix, length of stay, the ratio of intensive care unit beds to general beds, support services, nursing standards of care, physician practices, patient age and socioeconomic status, and the availability of nurses. Case mix ranked first (average rank = 1.7), followed by nursing standards (4.0), and skill mix (4.1). These three factors were at the top of the list for nurse executives and middle managers in both teaching and community hospitals. Several respondents also added that the age, education, and experience of the nursing staff were factors in the amount of nursing care given.

LIMITATIONS OF THE STUDY

Systematic reviews are only as good as the evidence they synthesize. Retrospective studies indicate associations and cannot establish cause and effect. Thus, our finding that nurse staffing is inversely related to mortality does not mean that increasing the number or mix of RNs in a hospital will necessarily reduce patient deaths. Efforts to lower costs could lead to 1) reduced nurse staffing levels and 2) higher patient acuity, since less severely ill patients will be treated on a out-patient basis and convalescing patients will be discharged sooner. Since sicker

patients are more like to die in the hospital, it is possible that the observed relationship between staffing and mortality is not causal, rather both are a result of cost containment efforts.

Our electronic search was limited to articles indexed under terms relating to nurse staffing levels. However, relevant articles may not have been indexed under these terms but rather under specific outcomes, such as falls, nurse safety, or readmission rates, which are of interest because they may be associated with nurse-to-patient ratios. To investigate this potential source of bias, we conducted limited supplemental searches on some of the above outcomes. We then reviewed a small sample of articles from each search to determine the frequency of articles that met our inclusion criteria. These searches did identify some articles of interest, although the results were consistent with those of the other articles reviewed. [24,50]

All systematic reviews are limited by the possibility of publication bias: the well known fact that studies with statistically significant results are more likely to be submitted for publication and more likely to be published than studies that do not find statistically significant results. We searched only the published literature on this topic. We did not search the "gray literature" of perhaps relevant, documented but unpublished reports, nor did we attempt to adjust for this "file drawer" problem of unpublished research by estimating the number of studies with opposite conclusions that would have to be found to reverse our conclusions.

No matter how good the evidence, it must still be interpreted. Many results were expressed as regression coefficients, which are difficult to interpret. A regression coefficient is the slope of a line showing the relationship between an input (some measure of nurse staffing) and an output (an outcome). As such, the coefficient represents the trade-off between inputs and outputs. However, deciding whether the trade-off is desirable is a value decision. For example, is it desirable to increase skill mix by 2% more RNs to prevent 1 additional adverse event in every 1,000 patient days? What if the adverse event is as serious as death? As treatable as a urinary tract infection? As intangible as a drop in patient satisfaction? Further, the cost of increasing skill mix by 2% more RNs varies geographically and over time, so the trade-offs are simply not straightforward. Our grading of the clinical importance of each finding was done by consensus among three reviewers; however, others may interpret the evidence differently.

Interpreting the importance of an adverse event rate is confounded by a lack of knowledge about the severity of the event. For example, the implications of pressure ulcers are confounded by the fact that the clinical and financial consequences of superficial ulcers (Shea Stage I or II) may differ substantially from those of deeper ulcers (Stage III or IV). Only one study we examined reported a measure of severity for the outcome variable (falls producing serious injury). With the exception of mortality, this problem of interpretation exists for all adverse events, including pressure ulcers, medication errors, infections, procedure errors, and so on. Severity must be reported if the clinical implications of an adverse event are to be determined.

Another potential limitation is that we were often not able to assess the baseline rate of adverse outcomes and so could not determine whether staffing changes could lower these rates. In other words, we could not rule out a "floor effect." To prevent errors, somebody has to be making them. If the baseline error rate is already low, changes in nurse staffing may show no effect. Alternatively, where baseline rates are high, identical staffing changes may produce great benefit. Related to the issue of baseline rates is the problem that occurs when results were

reported as relative differences. For example, Needleman, [16] in a study of 799 hospitals nationwide, found that increasing RN hours worked per day from a mean of 6.4 to a mean of 9.1 decreased the rate of urinary tract infections between 4.9% and 12%, depending on the regression model used. A relative drop of 12% seems substantial; however, the highest UTI rate was 7.5%, so even a 12% drop (the best case situation) results in a final rate of 6.6% (12% of 7.5% = 0.9%; 7.5% - 0.9% = 6.6%).

Many studies analyzed data from incident reports or medical records. However, the medical record may not contain the data required to measure the quality of nursing care.[18]

Aside from three studies of readmission rates as an outcome to the effect of discharge planning (cited above but not included in the articles reviewed), we found no studies with follow-up periods beyond hospital discharge. If the effects of quality nursing care do not appear until after discharge, as suggested by Verran, [18] such effects would not have been detected in the studies we reviewed.

We purposely did not review the many studies of nurse staffing levels that have been conducted in other countries because of obvious and marked differences in health care systems among countries. However, some of these studies may nevertheless be applicable to the study questions (see, for example, Aiken et al. [51]).

CONCLUSIONS

1. Increases in the number of RNs, and to a lesser extent, richer RN skill mixes, are probably associated with reduced in-hospital mortality.

2. Increases in the number of RNs and, to a lesser extent, RN hours worked per patient day, are probably associated with reduced rates of pneumonia.

3. Increases in total nursing hours worked per patient day and, to a lesser extent, richer RN skill mixes, are probably associated with reduced hospital length of stay.

4. More or richer nurse staffing may be associated with lower rates of nosocomial infections, urinary tract infections, pressure ulcers and medication errors, and increased documentation of patient problems.

5. The evidence generally is insufficient or does not support strong or consistent associations between richer nurse staffing ratios or RN skill mixes and: 1) rates of falls, pressure ulcers, or procedure errors; 2) measures of patient satisfaction or perceptions of quality of care, patient care monitoring, and nurse absenteeism, turnover, or vacancy rates; and 3) the amount of direct patient care.

6. Increasing the number of RNs or enriching the RN skill mix does not appear to increase institutional costs and may even reduce costs when the expenses of adverse patient outcomes are considered.

7. The literature offers no specific support for establishing minimum nurse-to-patient ratios for nursing units in acute care hospitals, especially in the absence of adjustments for case mix and skill mix.

8. A minimum nurse-to-patient ratio alone is probably not adequate to ensure quality of care. Patient acuity, [Glandon1989; Kravitz1992] skill mix, [Glandon1989; Prescott 1993] nurse competence, nursing process variables, technological sophistication, and institutional support of nursing [Aiken] should also be considered when setting minimum staffing requirements.

9. Aside from patient, nurse, or physician satisfaction with nursing care, the literature reviewed did not use positive outcomes to assess nursing quality. This possibility should be explored. However, such outcomes may not occur or be recorded during the hospital stay but may be reflected only in postdischarge changes in health behaviors.

. 1 . 2 1 . 1 . 1 *REFERENCES*

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1. Verran JA. Quality of care, organizational variables, and nurse staffing. In: Wunderlich, GS, Sloan FA, Davis CK, editors. *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* Institute of Medicine, Division of Health Care Services. Washington DC: National Academy Press, 308-32, **1996**.

2. Office of Healthcare Access. *Nurse-to-Patient Ratio Study. A Report on the Current Nursing Environment in Connecticut Hospitals*. State of Connecticut Office of Health Care Access, February **2000**.

3. Prescott PA. Nursing: an important component of hospital survival under a reformed health care system. *Nurs Econ* **1993**;11:192-9.

4. American Nurses Association. *Nurse Staffing and Patient Outcomes.* Washington DC: American Nurses Association, **2000.**

5. Aiken LH, Sochalski J, Anderson GF. Downsizing the nursing workforce. *Health Affairs* **1996**;15:88-92.

6. Donovan MI, Kewis G. Increasing productivity and decreasing costs: the value of RNs**.** *JONA* **1987**;17:16-8.

7. Helt EH, Jelinek RC. In the wake of cost cutting, nursing productivity and quality improve. *Nurs Manage* **1988**;19:36-48.

8. Shindul-Rothchild J, Berry D, Long-Middleton E. Where have all the nurses gone? *AJN* **1996**; 96:25-39.

9. Spetz J, Seago JA, Coffman J, Rosenhoff, O'Neil E. *Minimum Nurse Staffing Ratios in California Acute Care Hospitals*. Center for the Health Professions, University of California, San Francisco, **2000.**

10. Hinshaw AS, Scofield R, Atwood JR. Staff, patient, and cost outcomes of all-registered nurse staffing. *JONA* **1981**; Nov-Dec:30-6.

11. Flood SD, Diers D. Nurse staffing, patient outcome, and cost. *Nurs Manage* **1983**;19:34-43.

12. Arndt M, Bigelow B. The impact of individual and contextual factors on nursing care and the implementation of AHCPR practice guidelines. *Med Care Rev* **1994**;51:61-82.

4. Ballard KA, Gray RF, Knauf RA, Uppal P. Measuring variations in nursing care per DRG. *Nurs Manage* **1993**;21:33-41.

5. Scott W, Shortell S. Organizational performance: managing for efficiency and effectiveness. In Shortell S, Kaluzny A, editors. *Health Care Management: A Text in Organizational Theory and Behavior.* New York: JohnWiley & Sons, **1983**.

6. Blegen MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. *Nurs Res* **1998**;47:43-50.

7. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelvinsky K. *Nurse Staffing and patient Outcomes in Hospitals*. Final Report of US DHHS Health Resources and Services Administration Contract No. 230-99-0021, Feb, **2001**.

8. Reed L, Blegen MA, Goode CS. Adverse patient occurrences as a measure of nursing care quality. *JONA* **1998**; 28:62-9.

9. Verran JA. Quality of care, organizational variables, and nurse staffing. In: Wunderlick GS, Sloan FA, Davis CK, editors. *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* Institute of Medicine, Washington DC: National Academy Press, **1996**.

10. Lang T, Secic M. *How to Report Statistics in Medicine: Annotated Guidelines for Authors, Editors, and Reviewers*. Philadelphia: American College of Physicians, **1997**.

11. Prescott PA, Dennis KE, Creasia JL, Bowen SA. Nursing shortage in transition. *Image* XVII:127-33, **1985**.

12. DeMoro D. Engineering a crisis: how hospitals created a shortage of nurses. *Revolution* **2000**;1:3-8.

13. Walker EK. Staffing accommodations to hospital unit admissions. *Nurs Econ* **1990**;8:314-8.

14. Mark B, Burleson DL. Measurement of patient outcomes. Data availability and consistency across hospitals. *JONA* **1995**;25:52-9.

15. Al-Haider AS, Wan TTH. Modeling organizational determinants of hospital mortality. *Health Sys Res* **1991**;26:303-23.

16. Mumford E, Schlesinger HJ, Glass GV. The effects of psychological intervention of recovery from surgery and heart attacks: an analysis of the literature. *AJPH* **1982**;72:141-5.

17. Devine EC, Cook TD. A meta-analytic analysis of effects of psychoeducational interventions on length of postsurgical hospital stay. *Nurs Res* **1983**;32:267-74.

18. American Nurses Association. *Standards of Nursing Practice*. Kansas City: American Nurses Association, **1973**.

19. Joint Commission on Accreditation of Hospitals. *Accreditation Manual for hospitals, 1981 edition*. Chicago: Joint Commission on Accreditation of Hospitals, **1981.**

20. Hogan AJ, Rohrer JE. The effects of nursing and physician services: preliminary results. *Soc Sci Med* **1989**;29:527-36.

21. Marchette L, Holloman F. Length of stay: significant variables. *JONA* **1986**;16:12-9

22. Brooten D, Kumar S, Brown LP, Butts P, Finkler SA, Bakewell-Sachs S, et al. A randomized clinical trial of early hospital discharge and home follow-up of very-low-birth-eight infants. *New Engl J Med* **1986**;315:934-9.

23. Neidlinger SH, Scroggins K, Kennedy LM. Cost evaluation of discharge planning for hospitalized elderly. *Nurs Econ* **1987**;5:225-30.

24. Naylor M, Brooten D, Jones R, Lavizzo-Mourey R, Mezey M, Pauly M. Comprehensive discharge planning for the hospitalized elderly: a randomized clinical trial. *Ann Intern Med* **1994**;120:999-1006.

25. American Nurses Association. *Nurse Staffing and Patient Outcomes in the Hospital Setting*. Washington, DC: American Nurses Publishing, **2000.**

26. Rogers B. Nursing injury, stress, and nursing care. In: Wunderlick GS, Sloan FA, Davis CK, editors. *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* Institute of Medicine, Washington DC: National Academy Press, **1996**.

27. Aiken LH, Sloane DM, Lake ET, Sochalski J, Weber AL. Organization and outcomes of inpatient AIDS care. *Med Care* **1999**;29:43-50.

28. Anon. Survey: consumers want higher nurse/patient ratios. *Hosp Health Netw* **1994**; 68: 24.

29. De Moro D. Engineering a crisis: how hospitals created a shortage of nurses. *Revolution* **2000**;1:3-8

30. Carter JH, Mills AC, Homan SM, Blaesing SL, Heater BS, Stoll LD, et al. Correlating the quality of care with nursing resources and patient parameters: a longitudinal study. *NLN* Publication 1987;Dec:331-45.

31. Ceria CD. Nursing absenteeism and its effects on the quality of patient care. *JONA* **1992**;22:11, 38.

32. Kuhn EM, Hartz A, Gottlieb MS, Rimm AA. The relationship of hospital characteristics and the results of peer review in six large states. *Med Care* **1991**;29:1028-38.

33. Hinshaw AS, Scofield R, Atwood JR. Staff, patient, and cost outcomes of all-registered nurse staffing. *J Nurs Admin* **1981**;Nov-Dec:30-6.

34. Bloom JR, Alexander JA, Nuchols BA. The effect of the social organization of work on the voluntary turnover rate of hospital nurses in the United States. *Soc Sci Med* **1992**;34:1413-24.

35. Duquette A, Sandhu BK, Beaudet L. Factors related to nursing burnout: a review of the empirical knowledge. *Issue Mental Health Nurs* **1994**;15:337-58.

36. Lanza ML, Kayne HL, Gulliford D, Hicks C, Islam S. Staffing of inpatient psychiatric units and assault by patients. *J Am Psychiatr Nurses Assoc* **1997**;3:42-8.

37. Shukla RK. All-RN model of nursing care delivery: a cost-benefit evaluation. *Inquiry* **1983**;20:173-84.

38. Arndt M, Crane S. Influences on nursing care volume. J Soc Health Sys **1998**;5:38-49.

39. Ballard KA, Gray RF, Knauf RA, Uppal P. Measuring variations in nursing care per DRG. *Nurs Manage* **1993**;21:33-41.

40. Kirby KK. Survey regarding factors influencing nursing hours. *Nurs Econ* **1986**;4:310-13.

41. Garrett B, Singiser D, Banks SM. Back injuries among nursing personnel. *AAOHNJ* **1992**;40:510-6.

42. Aiken LH, Clarke SP, Sloane DM, Sochalski JA, Busse R, Clarke H, et al. Nurses' reports on hospital care in five countries. *Health Affairs* **2001**;20:43-53.

Table 1. Questions Addressed in the Literature: **Purposes and Response Variables of Studies on the Effects of Nurse Staffing**

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Aiken 2000	To describe changes in US hospitals during the late 1980s and throughout the 1990s.	• Excess Medicare inpatient mortality	43. % difference between actual and estimated mortality of Medicare inpatients	1997 Medpar Mortality Data file; AHA 1998 annual survey
ANA 1996	Within a broad cross-section of hospitals, are shorter LOS and lower adverse patient outcome rates associated with higher nursing skill mixes and/or higher staffing levels?	• Length of Stay • Pneumonia • Post-op infections • Pressure ulcers • Urinary Tract Infection	• Relative LOS Index = actual geometric mean ÷ expected geometric mean 44.Adverse Outcome Indices = actual adverse outcomes ÷ expected adverse outcomes	California, Massachusetts, and New York hospital databases
ANA 1999	Purpose: To statistically test the relationships between nurse staffing and specific patient outcome indicators	• Length of Stay • Pneumonia • Post-op infections • Pressure Ulcers • Urinary Tract Infection	45. Relative LOS Index = actual geometric mean ÷ expected geometric mean 46. Adverse Outcome Indices = actual adverse outcomes ÷ expected adverse outcomes	California, Massachusetts, and New York hospital databases

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Arbesman 1999	Nursing adequacy, as defined by the provided to expected nursing ratio, will be significantly lower for the cases than the controls.	• Falls	47. # of 1st-time falls	QA records
Arndt 1998	1) A greater proportion of RNs will be associated with higher hours of nursing care per case 2) Higher occupancy will be associated with lower nursing care volume/case 3) Lower staffing levels will be associated with lower nursing care volume/case 4) Greater opportunity to assess need for nursing care will be associated with higher hours of nursing care/case	• Skill mix • Occupancy • Staffing • Length of Stay	48. Proportion of RN to other nursing staff 49. Occupancy from all nursing units 50. Productive payroll hours/patient day 51. Actual (LOS – 1 day)	Hospital data
Behner 1990	To examine the empirical relationship between nurse staffing level and patient length of stay.	• Length of stay • Complications	52. # days 53. # of any of 10 specified complications	Chart review
Blegen 1998A	To describe, at the level of nursing care unit, the relationships among total hours of nursing care, RN skill mix, and adverse patient outcomes	• Medication errors • Falls (all) • Pressure ulcers • Infections (respiratory and urinary) • Complaints	54. # / 100,000 cases 55. # / 1,000 patient days 56. # / 1,000 patient days 57. # / 1,000 patient days 58. # / 1,000 patient days	• Incident reports • Incident reports • Chart review • Chart review • Patient Representative's office

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
		• Mortality	59. # / 1,000 patient days	• Chart review
Blegen 1998B	To examine, at the level of patient care unit, where specific staffing ratios are implemented, the relationship between nurse staffing and patient outcomes while controlling for average acuity of patients	• Medical administration errors • Medication errors (rate) • Falls (with and without injury) • Cardiopulmonary arrests (successful or not)	60. # errors / 1,000 patient days 61. # errors / 10,000 doses 62. # falls / 1,000 patient days 63. # arrests / 1,000 patient days	CORS file and supplemented by hospitals
Bloom 1997	The higher the ratio of RNs to total nursing staff, the higher the operating costs are expected to be	• Personnel costs	64. Combined payroll and benefit costs divided by total hospital admissions	AHA Survey (20% random)
Bond 1999	To test the association between mortality rates (adjusted for severity of illness for Medicare patients) in 3763 U.S. hospitals	• Mortality	65. Mean # deaths/hospital/year	HCFA data
Bostrom 1993	To evaluate a redesign in nursing care that included introduction of nurses aides, increase in RN to patient ratios, and automated drug administration systems. Relevant endpoints: patient satisfaction with cost of and quality of nursing care.	• Patient care costs • Patient satisfaction • Quality of nursing care	66. Acuity-adjusted cost / patient day 67. Mean score on question, range 1-5 68. # incident reports / 1000 patient days/1 quarter (3 m); 1 = ave # incidents; <1 = < ave#; unit mean (hospital mean)	Calculated 6 questions scored 1-5 Incident reports
Bradbury 1994	Do hospitals with better health outcomes (lower mortality, or morbidity) spend	• Major morbidity (in hospital)	69. Admission severity group 3 or 4 (0 to 4 scale) on days through 6	Chart review

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
	more or less to accomplish these results?	• Mortality (in hospital)	70. Not stated	Chart review
Carter 1987	"To correlate indicators of quality care wit various nursing resources and patient parameters and to predict which structural elements would yield quality nursing care."	• Care Plan Index (quality of the nursing plan) • Nursing Record Index (quality of documentation) • Nursing Care Index (quality of care)	71. Proportion of affirmative answers to questions formulated for each index	Data collected by trained observers
Ceria 1992	To explore the relationship between nurses' absenteeism and the quality of patient care	• Medication errors • Incident reports • Adherence to environmental and IV monitoring plans • Falls • Care plan monitoring • Crash cart monitoring	Not available	Not available
Dobal 1995	Is resource allocation related to nursing unit performance?	• Vacancy rate • Turnover rate • Medication error rates • Patient falls • Tech quality of care • Meeting family needs • Supportive nursing behavior	72. Percent 73. Percent 74. Percent 75. Percent 76. Likert scale 77. Likert scale 78. Likert scale	Survey
Flood 1988	What effects does nurse staffing have on patient complications, acuity levels, LOS, and cost, controlling for DRG? Outcomes for two units, A& B, were studied, where unit A had inadequate staffing.	• Complication rate • Length of Stay • Length of Stay	79. # of complications / patient /unit (range of 1 - 4) 80. # above geometric mean for hospital 81. mean/unit	Performance improvement records Hospital data Hospital data

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
		• Costs	82. Comparison of losses between Unit A and B	Hospital financial data
Glandon 1989	"To explore the role that the organization of nursing care delivery and staffing mix play on nursing labor costs."	• Total nursing costs per patient day • RN costs per patient day • Total nursing costs per unit workload	83. Dollars	Medicus Systems Corp.'s National Comparative Database
Grillo-Peck 1995	What effect does implementation of a nursing partnership model have on LOS, medication errors, falls, infection rates?	• Length of Stay • Falls • Medication errors • Procedure errors • Infection rate	84. # of days 85. # of reported monthly incidents 86. # of reported monthly incidents 87. # of reported monthly incidents 88. # of reported monthly incidents	Risk management data
Haley 1982	To identify the probable causes of an epidemic of infections among neonates in a special-care unit	• Infection rate	• Incidence density (No./10,000 patient days	Medical records
Halloran 1983	To describe the relationship between nursing diagnoses and time a nurse spends with a patient	• Mean cost per patient day (day shift only) • Relationship between hours of direct care and time spent in treating patients in each of Maslow's 5 Hierarchy of Needs categories	89. Cost per day ($) 90. Correlation coefficients	Nurse self-report of time and activities over 12 days

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Hartz 1989	To test the association of particular characteristics of hospitals with the mortality rate	• Mortality	91. Deaths/1,000 patients	HCFA data
Kovner 1998	To examine the relationship between nurse staffing and adverse events hypothesized to be sensitive to nursing care, while controlling for related hospital characteristics	• Venous thrombosis or embolism after invasive vascular procedure • Venous thrombosis or embolism after major surgery • Urinary tract infection • Pneumonia after major surgery • Pneumonia after invasive vascular procedure • Pulmonary compromise after major surgery • AMI after major surgery • Gastrointestinal hemorrhage after major surgery • Mechanical complications	92. # / 100 patients from population at risk	Nationwide inpatient sample
Krakauer 1991	To compare the results of risk adjustment based on claims data with those based on detailed physiologic and clinical data.	• Inpatient mortality	93. Death within 30 days of admission	HCFA data and MedisGroups System data
Kuhn 1991	To determine which hospital characteristics are associated with quality of care	• Quality of care (confirmed problem rate)	94. % of cases reviewed by the PRO that failed physician review	PRO reviews

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Kustaborder 1985	To determine whether accidents (falls) could be prevented in a sub-acute nursing unit	• Accidents (falls)	95. # accidents in 5 months	Incidence reports
Lanza 1997	1) To determine the relationship between the number and characteristics of nursing staff and the occurrence of assault in inpatient psychiatric units 2) Is there a direct relationship between patient/staff ratio and assault? Is gender of nursing staff a factor in assault?	• Severity of assault	96. 7-point assault rating scale	Collected each day on nursing report
	5)	• Number of assaults/shift	97. # + % of assaults/shift	Collected each day on nursing report
Manheim 1992	To explore the extent to which hospital resources and structure, patient severity, and regional environmental variables predict risk-adjusted Medicare hospital mortality across 9 U.S. census regions	• Hospital mortality	98. Deaths/1000 patients	HCFA data

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Needleman 2001	To identify "a broad range of outcomes potentially sensitive to nursing to capture the overall contributions of nurses in providing inpatient care."	• urinary tract infection • pneumonia • mortality • failure to rescue • gastrointestinal bleeding • shock • length of stay • pressure ulcers • CNS complications • sepsis • wound infection • pulmonary failure • metabolic derangement	• ranges of rates from 10 regression models	• National sample of HCFA discharge data for Medicare patients from 3,357 hospitals • Hospital discharge data from a sample of 799 hospitals from 11 states • Hospital-level and nursing-unit-level data from a ample of 256 California hospitals
Osinski 1980	To compare the staffing costs between an all-RN primary nursing surgical unit and 35 other surgical units using different models of nursing	• Cost per day per bed • Cost per day per 55-bed unit • Total nursing care hours • Total RN hours	99. $ 100.$ 101.mean hours/patient/day 102.mean hours/patient/day	Questionnaires sent to 110 hospitals; 40 responded; 35 were analyzed
Robertson 1999	Hospitals with higher staffing intensities of nurses and ancillary nursing personnel will have lower risk adjusted mortality rates for patients with COPD than hospitals with lower levels of intensities	• Mortality	103.Observed and predicted mortality for COPD patients	HCFA data

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Shamian 1994	To assess the relationship between length of hospital stay and nursing care hours	• Hours worked per patient day (HWPPD) on 11 types of nursing units	• Hours worked per patient day	GRASP Work Load Measurement System and National Comparative Database of Nursing Resource Consumption
Shortell 1988	To determine whether hospitals facing greater regulatory or payment constraints and a highly competitive market had poor patient outcomes than those that did not	• In-hospital mortality rates	104. Percent of admitted patients dying during hospitalization	Medical Provider Analysis and Review Data set
Shukla 1983	To determine whether individual nurse-related factors have greater impact than structural factors on the quality of care and the satisfaction of nurses	• Quality of patient care	105. 5-point scale	Qual PaC scale completed by trained raters
		• Nurse perceptions of quality of care	106. Mean of 47 scores, 1 – 5	47-item self-report, Likert questionnaire, Safford scale
		• Physicians' perception of quality	107. Mean of 47 scores, 1 – 5	39-item Likert questionnaire, Safford scale
		• Infection rate	108. # / month	Incident reports
		• Clinical care quality index	109. % of cases in which IV procedures are followed	In-house audit by expert raters
		• Amount of direct care	110. 1) Total nursing hours / patient day and 2) % of RN time spent in patient care	Work-sampling study
		• Costs	111. Total cost / patient day	Not stated

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Silber 1995	To determine whether hospital rankings based on complication rates provide the same information as hospital rankings based on mortality rates	• Mortality rates	• observed No. deaths – expected No. Deaths / No. patients undergoing CABG	• MedisGroup National Comparative Data Bases
		• Failure-to-rescue rates (death after complications)	• observed No. of failures to rescue – expected No. of failures to rescue / No. patients undergoing CABG	
		• Complication rates	• observed No. complications – expected No. complications / No. patients undergoing CABG	
Sovie 2000	1) To evaluate relationships of mix of staff and worked nursing hours per patient day to patient outcomes 2) To determine whether data suggest standards supportive of quality patient care and outcomes	• Pressure ulcers (Shea stage II - IV)	112.# of patients with ulcers/total number of patients	Direct Observation
		• Falls (with or without injury)	113.# of falls / 1000 patient days	Incident report
		• Serious fall-related injuries	114.# injuries / 100 falls	Incident report
		• Urinary Tract Infection	115.# patients with UTI per quarter / # patients discharged in same quarter	Incident reports or chart review
		• Patient satisfaction (6 dimensions)	116.0 (zero) low to 100 (high)	Questionnaire
Taunton 1994	1) To explore associations between [RN] absenteeism, unit separation, and workload with nosocomial infections, falls, and medication errors 10. 2) To determine whether any associations last more than one quarter or in more than one hospital 11.	• Nosocomial infections (UTI & bloodstream)	117.# infections / 1000 patient days	Variance forms
		• Falls	118.# falls / 1000 patient days	
		• Medication errors	119.# errors / 10,000 nursing hours	

Study	Research Question/Hypothesis	Response Variables	How Reported	Source of Data
Wan 1987	To determine how selected contextual and organizational variables influence incidence rates on medical-surgical nursing units	• Medication errors • IV administration errors • Patient falls • Patient injuries • Testing/treatment errors	120.# / 1000 patient days/3m	Hospital records

Table 2. Organizational Units Investigated in Studies on the Effects of Nurse Staffing

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Aiken 2000	Not reported/unclear	Not reported/unclear	Not reported/unclear	386 Institutions	Not reported/unclear
ANA 1996	48 University hospital/ academic medical centers 1520 Non-university hospitals 155 Non-university, teaching hospitals 1378 Non-university, non-teaching hospitals	Not reported/unclear	1076 Urban	1076 Institutions	Not reported/unclear
ANA 1999	502, Not reported/unclear	Not reported/unclear	Not reported/unclear	502 Institutions	Not reported/unclear
Arbesman 1999	1 Non-university hospital	1 Very large	1 Urban	252 Patient cases; 252 Patient controls	Not reported/unclear
Arndt 1998	5 Non-university hospitals 5 Non-university, non-teaching	5 Large and medium	5 Urban	5 Institutions	Not reported/unclear

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Behner 1990	1 Not reported/unclear	1 Not reported/unclear	1 Not reported/unclear	1 Nursing unit 132 Patients	1 Orthopedics
Blegen 1998 A	1 University hospital/academic medical center	1 Very large	Not reported/unclear	1 Institution 42 Nursing units	10 General medical care 5 General surgical care 3 Gynecology 3 Neurology 3 Orthopedics 8 Pediatric 4 Psychiatric/behavioral health 4 Critical care 2 ENT; Urology
Blegen 1998 B	11 hospital consortium	4 Large 2 Medium 5 Small	11 Not reported/unclear	11 Institutions 39 Nursing units	24 Combined general med/surg 4 Labor and delivery 3 Skilled Units 8 ICU
Bloom 1997	583, Not reported, unclear	Mean = 195 beds $\pm$ 181	58% Urban	583 Institutions	Not reported, unclear
Bond 1999	3763 Not reported/unclear	3763 Not reported/unclear	3763 Not reported/unclear	3763 Institutions	Not reported/unclear
Bostrom 1993	1 University hospital/academic medical center	1 Very large	1 Urban	1 Institution 3 Nursing units	2 General medical care 1 General surgical care

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Bradbury 1994	4 University hospital/academic medical center 5 Non-university, teaching	Not reported/unclear	8 Rural	43 Institutions	Not reported/unclear
Carter 1987	1 academic hospital and trauma center	362-bed hospital	1 Urban	12 Nursing units; 914 quality reviews	1 Coronary stepdown 1 Medical ICU/CCU 1 Specialty medicine 1 Cardiac surgery stepdown 1 Surgical ICU 1 Cardiovascular Surg. ICU 1 Gen. Surgery 1 Neurology 1 Oncology 1 Orthopedics 1 General medicine 1 ENT
Ceria 1992	1 Non-university hospital	1 Not reported/unclear	1 Urban	1 Institution 6 Nursing units	1 Oncology 1 Telemetry Skilled nursing facility Intensive care

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Dobal 1995	21 Not reported/unclear	21 Not reported/unclear	21 Not reported/unclear	46 Nursing units	11 Combined med-surg 13 General medical care 8 General surgical care 1 Gynecology 5 Oncology 8 Orthopedics 3 Rehabilitation 2 Skilled nursing units 1 day surgery
Flood 1988	1 Non-university, teaching hospitals	1 Large	1 Urban	1 Institution 2 Nursing units 497 Patients	2 General medical care
Glandon 1989	62 Not reported/unclear	Mean size = 425 beds (range = 98 to 1212 beds)	54 Urban 8 Not reported/unclear	394 Medical and surgical nursing units	Not reported/unclear
Grillo-Peck 1995	1 Non-university hospital	1 very large	1 Not reported/unclear	1 Nursing unit	1 Neurology
Haley 1982	1 large municipal hospital with a neonatal tertiary care referral center	Not reported	1 Urban	4 Neonatal special care units	1 ICU 1 Premature nursery 1 Intermediate-care nursery 1 team nursery
Halloran 1983	1 Veteran's hospital	1 Not reported/unclear	Urban	2 Nursing units 17 nurses 103 patients	1 Cardiovascular unit 1 Cardiology unit

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Hartz 1989	3100 Not reported/unclear	3100 Not reported/unclear	3100 Not reported/unclear	3100 Institutions	3100 Not reported/unclear
Kovner 1998	72 University hospital/academic medical centers 434 Non-university hospitals	88 Very large 88 Large 162 Medium 168 Small	368 Urban 138 Rural	506 Institutions	Not reported/unclear
Krakauer 1991	84 Hospitals representative of Medicare patients	84 Not reported/unclear	84 Not reported/unclear	84 Hospitals	Not reported/unclear
Kuhn 1991	1219 Not reported/unclear	1219 Not reported/unclear	1219 Not reported/unclear	1219 Institutions	Not reported/unclear
Kustaborder 1985	1 Non-university hospital 1 Non-university, non-teaching hospital	1 Very large	1 Not reported/unclear	1 Institution 1 Nursing unit	Not reported/unclear
Lanza 1997	1 VA hospital	1 Not reported/unclear	1 Urban	1 Institution 6 Nursing units	6 Psychiatric/behavioral health
Manheim 1992	3796 Not reported/unclear	3796 Not reported/unclear	3796 Not reported/unclear	3796 Institutions	Not reported/unclear
Needleman 2001	Not reported	Not reported	• National sample of 799 hospitals from 11 states • 256 California hosspitals reporting data by nursing	Not reported	Not reported

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
			unit • National sample of 3,357 hospitals for Medicare patients		
Osinski 1980	36 Hospitals	Not reported/unclear	110 in New Jersey	36 Nursing units	36 General surgical units
Robertson 1999	Not reported/unclear	Not reported/unclear	Not reported/unclear	Not reported/unclear	Not reported/unclear
Shamian 1994	58 hospitals across the US	Range: 100 to 600 beds	Not reported/unclear	1733 nursing units	Cardiac step-down Medical-surgical Neurologic Oncology Orthopedics Neonatal Obstetrics Pediatrics Psychiatric Rehabilitation
Shortell 1988	981 Hospitals	981 Not reported/unclear	981 in 45 states	981 Hospitals 214,839 patients	Not reported/unclear
Shukla 1983	1 Not reported/unclear	1 Very large	1 Urban	1 Institution 3 Nursing units	3 Combined med-surg
Silber 1995	57 hospitals	Not reported/unclear	Not reported/unclear	16,673 patients	Not reported/unclear

Study	Institutions by type (n)	Institutions by Size* (n)	Institutions by Location (n)	*Unit of Observation* (n)	Nursing Units By Type (n)
Sovie 2000	29 University hospital/academic medical centers	Not reported/unclear	Not reported/unclear	29 Institutions	Not reported
Taunton 1994	1 University hospital/academic medical center 3 Church-related hospitals	Not reported/unclear ("large")	4 Urban	4 Institutions 65 Nursing Units	22 Combined med-surg 6 Obstetrics/Gynecology 6 Pediatric 5 Telemetry unit 15 Critical care 4 Long-term care 7 "Other"
Wan 1987	45 Non-university hospitals	45 Not reported/unclear (range 67 – 617 beds)	45 Not reported/unclear (national sample)	45 Institutions	Combined general med/surg

*Institution size: Very large (>500 beds), Large (>300 beds, ≤ 500 beds), Medium (>100 beds, ≤ 300 beds), Small (≤ 10 beds), or Not reported/unclear

Table 3. Summary of Studies on the Effects of Nurse Staffing on Nosocomial Infections (Combined or Unspecified)

Study	.1.1 Internal .2.1 Validity .3.1 External Validity Design Duration (m) Bias Age of Data # Hospitals # Units # Patients	.4.1 Effects On Nosocomial Infections .5.1 (Combined or Unspecified)	.6.1 Clinical Grade Statistical Grade
Shukla 1983	Prospective 10 m Low bias 1983 1 3 . . .	1. **Nursing model (skill mix) had no effect on infection rates.** The rate was 2.1infections/ month on the Primary Care Nursing unit (100% RN), 1.9 infections/ month on the Modular Nursing unit (50% RN/ 50% LPN), and 2.2 infections/ month on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP) [P = 0.5 to 0.7]. p.181	**0** **0**
Blegen 1998 A	Retrospective 12 Low bias 1993 1 42 21,783	2. Total hours of nursing care was not associated with urinary or respiratory tract infection rates [β = +0.46; P > 0.1. Mean rate = 3.4/1,000 patient days; range, 0 to 11/1,000 patient days]. p.48. **Although not clinically or statistically significant, each additional hour of care/patient day was associated with an *increase* in 0.5 of an infection/1,000 patient days.**	**(0)** **0**
		3. Skill mix was not associated with urinary or respiratory tract infection rates [β = -0.24; P > 0.1. Mean rate = 3.4/1,000 patient days; range, 0 to 11/1,000 patient days] p.48. **An additional 10% of RN staffing would prevent 2.5 infections/1,000 patient days.**	**0** **0**

ANA 1997 (same as Lichtig 1999)	Retrospective 24 high bias	1992 547	4. In 352 California hospitals, a richer RN skill mix was statistically associated with a small decrease in postoperative infection rates [β = -0.53; P < 0.05]. Mean skill mix was 71%. p.29. **Each 10% increase in the proportion of RNs in the skill mix was associated with about a 5% decrease in the rate of postoperative infections.**	**1 1**
			5. **In 126 New York hospitals, no statistical association was found between skill mix and postoperative infection rates.** [β not reported if P > 0.05]**.** Mean skill mix was 61%. p.29	**0 0**
		1994 547	6. In 295 California hospitals, a richer RN skill mix was statistically associated with a small decrease in postoperative infection rates [β = -0.47; P < 0.05]. Mean skill mix was 71%. p.29. **Each 10% increase in the proportion of RNs in the skill mix was associated with about a 5% decrease in the rate of postoperative infections.**	**1 1**
			7. **In 131 New York hospitals, no association was found between RN% and postoperative infection rates.** [β not reported if P > 0.05]. Mean skill mix was 62%. p.29	**0 0**
Grillo-Peck 1995	Retrospective 12 Moderate bias	1992-93 1 1 71	8. **Changing from a skill mix of 80% RN to 60% RN, while increasing the total number of caregivers on a neuroscience unit (DRG 14: cerebrovascular disease) was not associated with changes in infection rates** [11.2 vs. 8.8 infection/m; P = 0.09 for the difference of 2.4 infections/m]. p.370	**(0) 0**

Taunton 1994	Retrospective 6 high bias	1990 4 65 . . .	9. RN absenteeism (2.9 to 4.2 days lost/100 days scheduled) was statistically and directly correlated with infection rates in 2 of 4 hospitals in 6 of 8 quarters [overall mean rates = 0.4 to 1.7; range, 0 to 5; r = 0.53 to 0.77; P < 0.05]. p.53 **Absenteeism explained between 28% and 59% of the variation in infection rates, but not consistently across time or hospitals.**	**0 1**
Haley 1982	Retrospective 21 low	1972-73 1 1 15,985 (infants)	10. **On a neonatal intermediate care unit, the relative risk of infants acquiring staphylococcal infections rose to 16.4 (95% CI = 7.0 to 40.0) during periods of understaffing,** defined as an infant-to-nurse ratio greater than 7 to 1 on more than 1 day in a consecutive 10-day period. [Overall attack rate = 51/1,000 discharges] p.880	**1 1**

Table 4. Summary of Studies on the Effects of Nurse Staffing on Urinary Tract Infections

.6.1.1.1	*.7.1 Internal* *.8.1 Validity* *.9.1 External* **Validity** **Design** **Duration (m)** **Bias**	**Age of Data** **# Hospitals** **# Units** **# Patients**	*.10.1 Effects on Urinary Tract Infections*	*.11.1 Clinical Grade* **Statistical Grade**
Sovie 2000	Prospective 36 Low bias		1. **Skill mix (median %RN = 56%, range 37% to 81%) was not associated with rates of urinary tract infections (median rate = 2.4/100 patients).** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.62	**0** **0**
		1997 29	2. **RN hours worked/patient day (median = 5 h, range 3.2 to 7.5 h) was not associated with rates of urinary tract infections (median rate = 2.4/100 patients).** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.62	**0** **0**
			3. **RN hours worked/patient day (median = 9 h, range 5.8 to 13.4 h) was not associated with rates of urinary tract infections on medical units (median rate = 2.4/100 patients).** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.62	**0** **0**
		1998 29	4. **Skill mix (median %RN = 57%, range 34% to 84%) was not associated with rates of urinary tract infections (median rate = 2.3/100 patients)** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.62	**0** **0**
			5. **RN hours worked/patient day (median 5.2h, range 2.9 to 10 h) was not associated with rates of urinary tract infections (median rate = 2.3/100 patients)** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.62	**0** **0**

6. Total Hours worked/patient day (median = 9.2 h, range 5.1 to 17.5) was inversely correlated with the rate of urinary tract infections on medical units [median rate = 2.3/100 patients; r = –0.42; P = 0.04 r^2 = 18%]. p. 62;115 (However: p.113 gives r as –0.65; P = 0.001). **HWPPD explained 18% of the variation in the rate of urinary tract infections in medical units among the hospitals.**	**? 1**

ANA 1997 (same as Lichtig 1999)	Retrospective 24 high bias	1992 547	7. In 352 California hospitals, a richer skill mix was statistically associated with a slight decrease in urinary tract infection rates [β = -0.64; P < 0.05]. Mean skill mix was 68%. p.29. **An additional 10% of RN staffing would theoretically lower the UTI rate by 6.4%.**	**1 1**
			8. **In 126 New York hospitals, no association was found between skill mix and urinary tract infection rates.** [β not reported if P > 0.05]. Mean skill mix was 61%. p.29	**0 0**
		1994 547	9. In 295 California hospitals, a richer skill mix was associated with a decrease in urinary tract infection rates [β = -0.65; P < 0.05]. Mean skill mix was 71%. p.29. **Each additional 10% of RN staffing was associated with a 6.5% lower UTI rate.**	**1 1**
			10. In 131 New York hospitals, a richer skill mix was associated with a decrease in urinary tract infection rates [β = -0.65; P < 0.05]. Mean skill mix was 62%. p.29. **An additional 10% of RN staffing would theoretically lower the UTI rate by 6.5%.**	**1 1**
Needle-man 2001	Retrospective 12 m moderate bias	1997 799	11. **In medical patients, increasing mean RN hours/pt. day from 6.4 to 9.1 decreased the rate of urinary tract infections by between 4% and 12%.** [Rates ranged from 4.9% to 7.5%. Relationship described as "strong and consistent"] p.101	**1 1**
			12. **In surgical patients, increasing mean RN hours/pt. day from 6.4 to 9.1 significantly but inconsistently decreased the rate of urinary tract infections by between 5% and 6%.** [Rates ranged from 2.7% to 7%. Relationship described as "some evidence"] p.101	**0 1**
			13. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 significantly and consistently decreased the rate of urinary tract infections by between 4% and 25%.** [Rates ranged from 4.9% to 7.5%. Relationship described as "strong and consistent"] p.101	**1 1**

			14. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 significantly but inconsistently decreased the rate of urinary tract infections by between 3% and 14%.** [Rates ranged from 2.7% to 7%. Relationship described as "some evidence"] p.101	**?** **1**
Kovner 1998	Cross-sectional 12 Moderate bias	1993 506	15. RN-adjusted hours/patient day was statistically associated with a decrease in the rate of urinary tract infections in at-risk surgical patients. [Mean rate = 4/100 discharges, range 0 to 25; β = -637; P < 0.001.] p.319. **"An increase of 0.5 RN h/day is associated with a decrease of 0.16 urinary tract infections/100 patients."**	**0** **1**
			16. The number of non RN hours/patient day was inversely associated with the rate of urinary tract infections [Mean rate = 4/100 discharges, range 0 to 25/100 discharges; β = -164; P < 0.001]. p.317-8. **No interpretation was given and the calculations could not be reproduced.**	**?** **1**

Table 5. Summary of Studies on the Effects of Nurse Staffing on Pneumonia

.11.1.1.1	*.12.1 Internal* *.13.1 Validity*	*.14.1 External* **Validity**	*.15.1 Effects on Pneumonia*	*.16.1 Clinical Grade*
	Design **Duration (m)** **Bias**	**Age of Data** **# Hospitals** **# Units** **# Patients**		**Statis-tical Grade**
ANA 1997 (same as Lichtig 1999)	Retrospective 24 high bias	1992 547	1. In 352 California hospitals, a richer RN skill mix was statistically associated with a decrease in the rates of pneumonia [β = -0.56; P < 0.05]. p.28. Mean skill mix was 68%. **An additional 10% increase in the proportion of RNs in the skill mix would theoretically decrease the rate of pneumonia by 5%.**	**1** **1**
			2. **In 126 New York hospitals, no association was found between the %RN and pneumonia rates.** [β not reported if P > 0.05]. Mean skill mix was 61%. p.28	**0** **0**
		1994 547	3. In 295 California hospitals, a richer RN skill mix was statistically associated with a slight decrease in the rates of pneumonia [β = -0.39; P < 0.05]. Mean skill mix was 71%. p.28. **An additional 10% increase in the proportion of RNs in the skill mix would theoretically decrease the rate of pneumonia by 4%.**	**1** **1**
			4. **In 131 New York hospitals, no association was found between the %RN and postoperative infection rates.** [β not reported if P > 0.05]. Mean skill mix was 62%. p.28	**0** **0**

Needle-man 2001	Retrospective 12 m moderate bias	1997 799	5. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 significantly and consistently decreased the rate of pneumonia by between 6% and 8%.** [Rates ranged between 0.6% and 3.6%. Relationship described as "strong and consistent."] p.101	**1 1**
			6. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 decreased the rate of pneumonia by 11%.** [Rates ranged between 0.1 and 5.4%. Relationship described as "weak."] p.101	**1 1**
			7. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 significantly and consistently decreased the rate of pneumonia by between 6% and 17%.** [Rates ranged between 0.6% and 3.6%. Relationship described as "strong and consistent."] p.101	**1 1**
			8. **In medical patients, increasing mean total nursing hours/pt. day from 9.7 to 13 decreased the rate of pneumonia by 19%.** [Rates ranged between 0.1 and 5.4%. Relationship described as "weak."] p.101	**1 1**
Kovner 1998	Retrospective 12 moderate bias	1993 506	9. RN FTEs/adjusted patient day was inversely associated with the rates of pneumonia after surgery. [Mean rate = 1/100 discharges, range 1 to 17; β = -159; 95%CI = -252.7 to -66.2; P < 0.001.] p.317. "**An increase of 0.5 RN h/patient day was associated with a 4.2% decrease in the rate of pneumonia."**	**1 1**
			10. **RN FTEs/adjusted patient day was not associated with the rate of pneumonia after invasive vascular procedures** [Data were not reported but were described as being not statistically significant; P > 0.05]. p.318	**0 0**
			11. **"Skill mix was inversely related to pneumonia after surgery although the size of this relationship was extremely small."** [β = -1.2; P < 0.004] p.318	**0 1**

Table 6. Summary of Studies on the Effects of Nurse Staffing on Patient Falls

.16.1.1.1	*.17.1 Internal* *.18.1 Validity* *.19.1 External* **Validity**	*.20.1 Effects On Patient Falls*	*.21.1 Clinical Grade* *.22.1*
	Design **Duration (m)** **Bias** **Age of Data** **#** **Hospitals** **# Units** **# Patients**		**Statis-tical Grade**
Sovie 2000	Prospective 36 Low bias 1997 & 1998 29	1 & 2. RN HWPPD (range, 3 to 10 h) was inversely and statistically associated with fall rates on medical and surgical units [maximum = 5 falls/1,000 patient days; β = -0.4, value computed from graph; P = 0.002]. p.56. **An increase of about 2.5 RN HWPPD would reduce fall rates by 1 fall/1,000 patient days on both types of units**.	**?** **1** **?** **1**
		3 & 4. HWPPD (range, 6 to 18 h) was marginally associated with fall rates on medical and surgical units [maximum = 5 falls/1,000 patient days; β = -0.15, value computed from graph; P = 0.07]. p.55. **An increase of about 1.5 RN HWPPD would reduce fall rates by 1 fall/1,000 patient days on both types of units.**	**1** **0** **1** **0**
Kusta-border 1985	Prospective 5 Moderate bias 1980 1 1 . . .	5. **Decreasing the RN/patient ratio from 1/15.2 to 1/18.3 on the unit was accompanied by a 3% increase in the percent of falls per admission** [21% vs. 24% over 1 year; P not reported]. p.161	**0** **0**

			6. **Increasing the presence of patient care staff on the unit at key times (by coordinating break times) did not reduce the percent of falls per admission** [21% vs. 24%; P not reported]. p.161	**0** **0**
Arbes-man 1999	Retrospecti ve 10 Moderate bias	1993 504 Patients	7. **The ratio of actual/expected nurse staffing did not differ significantly among 252 seniors who fell in the hospital and 250 matched controls who did not** [ratios not reported; difference between means = 0.021; P > 0.05]. Staffing adequacy did not predict falls [odds ratio 1.18 (95%CI = 0.78 to 1.79; P = 0.42). p.124	**0** **0**
Blegen 1998 A	Retrospecti ve 12 Low bias	1993 1 42 21,783	8. Total hours of nursing care/patient was not associated with fall rates [β = - 0.02; P > 0.1. Mean rate = 2.7/1,000 patient days; range, 0 to 16/1,000 patient days]. p.48. **Although not statistically or clinically significant, each additional hour of care/patient was associated with a decrease of 0.02 of a fall/1,000 patient days.**	**0** **0**
			9. A skill mix above 88% RN was not associated with fall rates [β = -0.30; P > 0.1. Mean rate = 2.7/1,000 patient days; range, 0 to 16/1,000 patient days] p.48. **Although not statistically or clinically significant, an additional 10% of RN staffing, above 88%, was associated with a decrease of 3 falls/1,000 patient days.**	**0** **0**
			10. A skill mix below 88% RN was not associated with fall rates [β = + 0.02; P > 0.1. No. falls ranged from 0 to 16/1,000 patient days.] p.48. **Although not statistically or clinically significant, each additional percent of RN staffing, up to 88%, was associated with an *increase* of 0.02 falls/1,000 patient days.**	**(0)** **0**

Blegen 1998 B	Retrospective 30 high bias	1993-1995 11 39 . . .	11. A higher proportion of RNs (mean = 73%) was statistically associated with a slightly lower rate of falls [β = -0.46; P < 0.05. Mean rate = 2.2 falls/1,000 patient days]. A 1% increase in RN skill mix was associated with a drop of 0.46 of a fall/1,000 patient days. p.200. **A 10% increase in RN skill mix would be required to decrease the rate by 4.6 falls/1,000 patient days.**	**1** **1**
			12. Total hours of care (mean 10.8) was not associated with the rate of falls [β = -0.05; P > 0.5. Mean rate = 2.2 falls/1,000 patient days]. p.200. **Although not statistically or clinically significant, total hours of care would have to be increased by a factor of 20 to prevent one additional fall.**	**0** **0**
Grillo-Peck 1995	Retrospective 12 Moderate bias	1992-93 1 1 71	13. **Changing from a skill mix of 80% RN to 60% RN, while increasing the total number of caregivers on a neuroscience unit (DRG 14: cerebrovascular disease) was associated with a drop in fall rate** [6.2 vs. 3.0 falls/m; P = 0.03 for the difference of 3.2 falls/m]. p.370	**(1)** **1**
Taunton 1994	Retrospective 6 high bias	1990 4 65 . . .	14. **RN absenteeism (2.9 to 4.2 days lost/100 days scheduled) was not associated with fall rates** [overall mean rate = 2.6; range, 0 to 14; data were not presented and were presumed to be clinically and statistically unremarkable]. p.54	**0** **0**
Ceria 1992	Retrospective 12 high bias	1992 1 6 . . .	15. **"Nursing absenteeism" was not related to the rates of falls.** The rates were not reported but were described as being not statistically significant. [P > 0.05].	**0** **0**
Wan 1987	Retrospective 3 Moderate bias	1985 45	16. RN hours/total daily nursing hours (mean = 52%) was not associated with fall rates [β = -0.45 P > 0.05]. p.64. **Although not statistically or clinically significant, each additional RN hour of care/total daily nursing hours was associated with a reduction in the rate of falls by 0.45 falls/1,000 patient days over 3 months.**	**0** **0**

			17. LPN hours/total daily nursing hours (mean = 30%) was not associated with fall rates [β = -0.43 P > 0.05]. p. 64. **Although not statistically or clinically significant**, **each additional LPN hour of care/total daily nursing hours was associated with a reduction in the rate of falls by 0.43 falls/1,000 patient days over 3 months.**	**0** **0**
Dobal 1995	Cross-sectional 0.25 Moderate bias	1994? 31 46 442 providers	18. Nurse-to-patient ratios were not correlated with the rate of patient falls [mean ratio = 0.2; range, 0.05 to 0.3; r = 0.23; P > 0.05]. p.119. **Nurse-to-patient ratios explained only about 5% of the variation in rate of falls**.	**0** **0**

Table 7. Summary of Studies on the Effects of Nurse Staffing on Pressure Ulcers

.22.1.1.1	*.23.1 Internal* *.24.1 Validity* *.25.1 External* **Validity**		*.26.1 Effects On Pressure Ulcers*	*.27.1 Clinical Grade*
	Design **Duration (m)** **Bias**	**Age of Data** **# Hospitals** **# Units** **# Patients**		**Statis-tical Grade**
Sovie 2000	Prospective 36 Low bias	1997 29	1. On medical units, RN hours worked/patient day was inversely associated with the rate of pressure ulcers [median rate = 3.2%; r = -0.41; P = 0.04]. p.62;114. **RN HWPPD explained 17% of the variation in the rates of pressure ulcers.**	**? 1**
			2. **Skill mix (% RN) was not associated with the rate of pressure ulcers.** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.62;114	**0 0**
		1998 29	3. **On medical units, RN HWPPD was not associated with the rate of pressure ulcers.** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.62;115	**0 0**
			4. **Skill mix (% RN) was not associated with the rate of pressure ulcers.** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.62;115	**0 0**

ANA 1997 (same as Lichtig 1999)	Retrospective 24 high bias		5. In 352 California hospitals, an increase in RN skill mix was statistically associated with a decrease in the rates of pressure ulcers [β = -0.79; P < 0.05]. Mean skill mix was 68%. p.27. **Although not statistically or clinically significant, each 10% increase in RN skill mix was associated with a 7.9% decrease in pressure ulcer rates.**	**1** **1**
		1992 547	6. In 126 New York hospitals, an increase in RN skill mix was statistically associated with a decrease in the rates of pressure ulcers [β = -1.8; P < 0.05]. Mean skill mix was 61%. p.27. **Each 10% increase in RN skill mix was associated with a 18.% decrease in pressure ulcer rates.**	**1** **1**
			7. **In 352 California hospitals, total nursing hours/acuity-adjusted patient day was not associated with the rate of pressure ulcers.** [β not reported if P > 0.05]. Mean nursing hours/day was 7.6. p.27	**0** **0**
			8. In 126 New York hospitals, total nursing hours/acuity-adjusted patient day was associated with a decreased rate of pressure ulcers [β = -17.9; P < 0.05]. Mean nursing hours/day was 7.4. p.27. **For each 1-hour increase in total hours of care/patient day, the rate of pressure ulcers dropped by almost 18%.**	**1** **1**
		1994 547	9. In 295 California hospitals, an increase in RN skill mix was statistically associated with a slight decrease in the rates of pressure ulcers [β = -1.2; P < 0.05]. Mean skill mix was 71%. p.27. **Each 1% increase in RN skill mix was associated with a 1.2% decrease in pressure ulcer rates.**	**1** **1**

			10. In 131 New York hospitals, an increase in RN skill mix was statistically associated with a decrease in the rates of pressure ulcers [β = -1.2; P < 0.05]. Mean skill mix was 62%. p.27. **Each 1% increase in RN skill mix was associated with a 1.2% decrease in pressure ulcer rates.**	**1** **1**
			11. In 295 California hospitals, total nursing hours/acuity-adjusted patient day was associated with a decreased rate of pressure ulcers [β = -15.6; P > 0.05]. Mean nursing hours/day was 8.4. p.27. **For each 1% increase in hours of care/patient day, the rate of pressure ulcers dropped by almost 16%.**	**1** **1**
			12. **In 131 New York hospitals, total nursing hours/acuity-adjusted patient day was not associated with the rate of pressure ulcers.** [β not reported if P > 0.05]. Mean nursing hours/day was 8.5. p.27	**0** **0**
Needle-man 2001	Retrospecti ve 12 m moderate bias	1997 799	13. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 had "inconsistent" effects of the rate of pressure ulcers.** [Rates ranged between 3.1% and 9.2%. Relationship described as "inconsistent."] p.101	**0** **0**
			14. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had "no effect" of the rate of pressure ulcers.** [Rates ranged between 2.9% and 7.1%. Relationship described as "none."] p.101	**0** **0**
			15. **In medical patients, increasing mean total nursing hours/day from 6.4 to 9.1 had "inconsistent" effects of the rate of pressure ulcers.** [Rates ranged between 3.1% and 9.2%. Relationship described as "inconsistent."] p.101	**0** **0**
			16. **In surgical patients, increasing mean total nursing hours/day from 6.4 to 9.1 had "no effect" of the rate of pressure ulcers.** [Rates ranged between 2.9% and 7.1%. Relationship described as "none."] p.101	**0** **0**

			17. Total hours of nursing care/patient day was not related to the rate of pressure ulcers [β = +0.41; P > 0.1. Mean rate = 1.7/1,000 patient days; range, 0 to 15/1,000 patient days]. p.48. **Although not statistically or clinically significant, a 1-h/patient-day increase in nursing care was associated with an *increase* in ulcer rates of 0.4 ulcers/ 1,000 patient days.**	**(0)** **0**
Blegen 1998 A	Retrospective 12 Low bias	1993 1 42 21,783	18. A richer RN skill mix, up to 88% RN, was associated with lower rates of pressure ulcers [β = -0.49; P < 0.05. Mean rate = 1.7/1,000 patient days; range, 0 to 15/1,000 patient days]. A 1% increase in RN skill mix was associated with a drop in ulcer rates of about 0.5 for each 1,000 patient days. p.48. **Thus, a 2% increase in RN skill mix, up to 88% RN, would be required to prevent 1 ulcer in each 1,000 patient days.**	**1** **1**
			19. A richer RN skill mix above 88% RN was not associated with lower rates of pressure ulcers [β = +0.38; P > 0.1. Mean rate = 1.7/1,000 patient days; range, 0 to 15/1,000 patient days]. p.48. **Although not statistically or clinically significant, a 10% increase in RN skill mix was associated with an *increase* of about 4 ulcers for each 1,000 patient days.**	**(1)** **0**

Table 8. Summary of Studies on the Effects of Nurse Staffing on Mortality

.27.1.1.1	*.28.1 Internal Validity* *.29.1* / *.30.1 External Validity*	*.31.1 Effects On Patient Mortality*	*.32.1 Clinical Grade*
	Design Duration (m) Bias / **Age of Data # Hospitals # Units # Patients**		**Statistical Grade**
Blegen 1998 A	Retrospective 12 Low bias / 1993 1 42 21,783	1. Total hours of nursing care/patient day was not statistically related to hospital mortality rate [β = 0.36; P > 0.1 Mean rate = 0.6/1,000 patient days; range, 0 to 11/1,000 patient days] **Each 1-hour increase in nursing care/day was associated with an *increase* of 0.4 deaths/1,000 patient days.** p.48	**(1) 0**
		2. A higher skill mix, RN% above 88%, was not statistically associated with hospital mortality [β = 0.32; P > 0.1. Mean rate = 0.6/1,000 patient days; range, 0 to 11/1,000 patient days]. p.48. **Although not statistically or clinically significant, for each 1% increase in RN skill mix, mortality was associated with an *increase* of 0.3 deaths/1,000 patient days.**	**(1) 0**
		3. A higher skill mix, RN% up to 88%, was not statistically associated with lower hospital mortality [β = -0.28; P > 0.1. Mean rate = 0.6/1,000 patient days; range, 0 to 11/1,000 patient days]. p.48. **Although not statistically or clinically significant, for each 1% increase in RN skill mix, up to 88%, mortality decreased by 0.3 deaths/1,000 patient days.**	**1 0**

			4. **Total FTEs did not differ significantly between hospitals in the highest and lowest quartiles of mortality** [758 vs 842 FTEs; P > 0.05 for the 84 FTE difference in means]. p.63	**1** **0**
Bradbury 1994	Retrospective 12 high bias	1994 43	5. **Total staff/admission did not differ significantly between hospitals in the highest and lowest quartiles of mortality** [0.09 vs. 0.10; P > 0.05]. p.63	**0** **0**
			6. **RN/LPN ratio did not differ significantly between hospitals in the highest and lowest quartiles of mortality** [10.65 vs. 4.06; P > 0.05 for the 6.59 difference in means]. p.63	**0** **0**
Manheim 1992	Retrospective 12 high bias	1992 3796	7. Higher RN/adjusted admission rates (mean = 0.02) was associated with lower hospital mortality rates [β = -21.08; P < 0.001]. **For each additional RN per adjusted admission, mortality rate declined by 21 deaths/1,000 patients.** [This coefficient is 10 times larger, and conspicuously so, than any other variable in the model. Overall expected mortality for the 9 census regions was 11.8/1,000 patients] p.60	**1** **1**
			8. Higher non-RN/adjusted admission rates were not statistically associated with lower hospital mortality rates [β = -2.36; P > 0.05] **For each additional non-RN employee per adjusted admission, mortality rate declined by 2.4 deaths/1,000 patients**. [Overall expected mortality for the 9 census regions was 11.8/1,000 patients] p.60	**1** **0**

			9. **In 1989 (n = 1,791), RN, LPN, and UAP intensity (FTE per category/100 adjusted admissions: 1.8, 0.46, and 0.6, respectively) was not associated with 30-day, postadmission COPD mortality** [β = -0.022, -0.080, -0.022, respectively; P > 0.05]. p. 265	**0** **0**
Robert-son 1999	Retrospecti ve 36 high bias	1989 to 1991 . . . 1800 patients	10. **In 1990 (n = 1,784), RN, LPN, and UAP intensity (FTE per category/100 adjusted admissions: 1.8, 0.44, and 0.63, respectively) was not associated with 30-day, postadmission COPD mortality** [β = -0.012, -0.081, +0.040, respectively; P > 0.05]. p. 265	**0** **0**
			11. **In 1991 (n = 2,133), RN, LPN, and UAP intensity (FTE per category/100 adjusted admissions: 1.8, 0.43, and 0.63, respectively) was not associated with 30-day, postadmission COPD mortality** [β = +0.013, +0.013, +0.017, respectively; P > 0.05]. p. 265	**0** **0**
			12. **An increase in number of RNs/occupied bed was negligibly but statistically associated with a decrease in mortality rates among Medicare patients (mean annual number of deaths/hospital** [β = -0.0063; P < 0.001. Mean RNs/100 beds and deaths/1,000 admissions/ hospital/year = 56 and 550 for the lowest staffing quintile and 186 and 420 for the highest]. p.133	**0** **1**
Bond 1999	Retrospecti ve 12 high bias	1992 3763	13. **An increase in the number of LVNs/occupied bed was negligibly but statistically associated with mortality rates among Medicare patients (mean annual number of deaths/hospital)** [β = +0.0061; P < 0.001. Mean LVNs/100 beds and deaths/1,000 admissions/hospital/ year = 7.8 and 270 for the lowest staffing quintile and 85 and 828 for the highest]]. p.133	**0** **1**

			14. **Hospitals in the highest quartile of RNs/average daily census had lower mortality than hospitals in the lowest quartile of RNs/average daily census** [114.7 vs 117.8 deaths/1,000 patients; P < 0.001 for the -3.1 deaths/1,000-patients difference (95%CI = -4.5 to –1.7 deaths/1,000 patients)]. p.1722	**1** **1**
Hartz 1989	Retrospective 12 high bias	1986 3100	15. **Hospitals in the highest percent of RNs/all nurses had lower mortality than hospitals in the lowest quarter of RNs/all nurses** [113.1 vs 119.4 deaths/1,000 patients; P < 0.001 for the 6.3 deaths/1,000-patients difference (95%CI = -7.7 to – 4.8 deaths/1,000 patients)]. p.1722	**1** **1**
			16. **Hospitals in the highest percent of RNs/all nurses had lower adjusted (for patient acuity) mortality rates than hospitals in the lowest quarter of RNs/all nurses** [115 vs. 117.5 deaths/1,000 patients; P < 0.01 for the 2.5 deaths/1,000-patients difference in rates].	**1** **1**
Krakauer 1991	Retrospective 12 Moderate bias	1986 84 . . . 42,773 patients	17. In an analysis of HCFA claims data, **hospitals with the highest quartile of RN skill mix had lower adjusted mortality rates than did those with the lowest quartile of RN skill mix** [12.1 vs 15.7/100 patients; P < 0.01 for the difference between means of 3.6 deaths within 30 days of admission. Overall mean skill mix = 57% RN.] p.329	**1** **1**
			18. In an analysis that included clinical data, **hospitals with the highest quartile of RN skill mix had lower adjusted mortality rates than did those with the lowest quartile of RN skill mix** [12.8 vs 14.9/100 patients; P < 0.05 for the difference between means of 2.1 deaths within 30 days of admission. Overall mean skill mix = 57% RN.] p.329	**1** **1**

			19. **For patients undergoing cardiac bypass surgery, higher nurse-to-bed ratios were not associated with hospital mortality rates** [Mean mortality = 4.3%. RR = 0.97; 95%CI = 0.88 to 1.06; P > 0.10. The relative risk of death was 0.03 lower for the next highest quartile of nurse-to-bed ratios.] p.321	**0** **0**
Silber 1995	Retrospective 12 low bias	1992 57 . . . 16,673	20. **For patients undergoing cardiac bypass surgery, higher nurse-to-bed ratios were statistically associated with *higher* complications rates** [Mean complication rate = 43%. RR = 1.1; 95%CI = 1.1 to 11; P < 0.001. Relative risk of death was 0.09 *higher* for the next highest quartile of nurse-to-bed ratios] p.321	**(?)** **1**
			21. **For patients undergoing cardiac bypass surgery, higher nurse-to-bed ratios were not associated with rates of death from complications (the "failure to rescue" rate)** [Mean failure-to-rescue rate = 10%. RR = 0.95; 95%CI = 0.87 to 1.04; P > 0.10. Relative risk of death was 0.05 lower for the next highest quartile of nurse-to-bed ratios] p.321	**0** **0**
Needle-man 2001	Retrospective 12 m moderate bias	1997 799	22. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on mortality.** [Rates ranged between 2.1% and 3.6%. Relationship described as "none."] p.101	**0** **0**
			23. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on mortality.** [Rates ranged between 0.4% and 6%. Relationship described as "none."] p.101	**0** **0**
			24. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on mortality.** [Rates ranged between 2.1% and 3.6%. Relationship described as "none."] p.101	**0** **0**

			25. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on mortality.** [Rates ranged between 0.4% and 6%. Relationship described as "none."] p.101	**0** **0**
Shortell 1988	Retrospective 12 high bias	1984 981 . . . 214,839	26. **The percentage of RNs among hospital staff** **(mean = 21%) was not associated with mortality rates (mean = 11.2%)** [standardized coefficient = -0.05; P > 0.05]. p.1104.	**0** **0**
Aiken 2000	Cross-sectional . . . high bias	1997 336	27. **In 22 magnet hospitals known for quality nursing care, a higher RN FTE/average daily census ratio was correlated with lower expected in-hospital mortality rates among Medicare patients** [r = -0.49; P = 0.02]. Excess mortality ranged from +.03% to -3%. The ratios ranged from about 1.3 to 4.75 and explained 24% of the variability in these mortality rates [r^2 = 0.24] Expected death rates exceed actual death rates in only 2 of the 22 hospitals, however. p.463-4	**1** **1**
			28. **In 314 nonfederal hospitals, a higher RN FTE/average daily census ratio was not correlated with lower in-hospital mortality among Medicare patients** [r = -0.18; P = 0.02]. Excess mortality ranged from +2.5% to -4%. The ratios ranged from about 0.5 to 4.3 and explained 3.2% of the variability in mortality rates [r^2 = 0.032] Expected death rates exceed actual death rates in only about 35 of the 314 hospitals, however. p.463-4	**0** **1**

Table 9. Summary of Studies on the Effects of Nurse Staffing on Hospital Duration of Stay

.32.1.1.1	*.33.1 Internal* / *.34.1 Validity* / *.35.1 External* **Validity**	*.36.1 Effects On Hospital Duration of Stay*	*.37.1 Clinical Grade*
	Design Duration (m) Bias / **Age of Data # Hospitals # Units # Patients**		**Statistical Grade**
Sovie 2000	Prospective 36 Low bias / 1997 29	1. The number of RN hours worked/patient day (range 3 to 10 h) was inversely associated with LOS (range 4 to 5.3 d) on medical and surgical units [β = -0.1, value computed from graph; P = 0.04]. **An increase of 1 RN HWPPD was associated with a 0.1-day reduction in LOS on both types of units [**mean LOS was significantly shorter for surgical patients: difference = 0.5 days; P = 0.02]. p.68	**0 1**
		2. **Total hours worked/patient day was not associated with LOS on medical and surgical units** [Data not reported and so are assumed to be clinically and statistically unremarkable]. p.62	**0 0**
		3. **Nursing skill mix was not correlated with LOS on medical or surgical units** [Data not reported and so are assumed to be clinically and statistically unremarkable]. p.62	**0 0**
	1998 29	4. The number of RN hours worked/patient day was inversely associated with LOS on medical and surgical units [β = -0.1, value computed from graph; P = 0.04]. **An increase of 1 RN HWPPD was associated with a 0.1-day reduction in LOS on both types of unit** [mean LOS was significantly shorter for surgical patients: difference = 0.5 days; P = 0.02]. p.68	**0 1**

			5. HWPPD hours worked/patient day was inversely correlated with LOS on medical, but not on surgical, units [r = - 0.4; r^2 = 16%; P = 0.04]. p.115. **RN HWPPD explained 16% of the variation in LOS on medical units.**	**?** **1**
			6. **Nursing skill mix was not correlated with LOS on medical or surgical units** [Data not reported and so are assumed to be clinically and statistically unremarkable]. p.62	**0** **0**
ANA 1997 (same as Lichtig 1999)	Retrospecti ve 24 high bias	1992 547	7. In 352 California hospitals, %RN hours was inversely associated with mean hospital duration of stay index [β = -0.07; P < 0.05]. Mean skill mix was 68%. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 0.7%.**	**0** **1**
			8. In 126 New York hospitals, %RN hours was inversely associated with mean hospital duration of stay index [β = -0.19; P < 0.05]. Mean skill mix was 61%. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 1.9%.**	**0** **1**
			9. In 67 Massachusetts hospitals, %RN hours was inversely associated with mean hospital duration of stay index [β = -0.27; P < 0.05]. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 2.7%.**	**0** **1**
			10. In 352 California hospitals, total nursing hours/pt.day, adjusted for acuity, was inversely associated with mean hospital duration of stay index [β = -4.8; P < 0.05]. Mean nursing hours/day was 7.6. p.27. **Each additional hour of nursing care/patient was associated with a decrease in expected LOS of 4.8%.**	**0** **1**

	11. In 126 New York hospitals, total nursing hours/patient day, adjusted for acuity, was inversely associated with mean hospital duration of stay index [β = -6.5; P < 0.05]. Mean nursing hours/day was 7.4. **Each additional hour of nursing care/patient was associated with a decrease in expected LOS of 6.5%.**	**1** **1**
	12. In 67 Massachusetts hospitals, total nursing hours/patient day, adjusted for acuity, was inversely associated with mean hospital duration of stay index [β = -9.7; P < 0.05]. p.27. **Each additional hour of nursing care/patient was associated with a decrease in expected LOS of 9.7%.**	**1** **1**
1994 547	13. In 295 California hospitals, %RN hours was inversely associated with mean hospital duration of stay index [β = -0.16; P < 0.05]. Mean skill mix was 71%. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 0.6%.**	**0** **1**
	14. In 131 New York hospitals, %RN hours was inversely associated with mean hospital Duration of stay index [β = -0.11; P < 0.05]. Mean skill mix was 62%. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 1.1%.**	**0** **1**
	15. In 76 Massachusetts hospitals, %RN hours was inversely associated with mean hospital duration of stay index [β = -0.19; P < 0.05]. p.27. **Each 10% increase in RN skill mix was associated with a decrease in expected LOS of 1.9%.**	**0** **1**
	16. In 295 California hospitals, total nursing hours/patient day, adjusted for acuity, was inversely associated with mean hospital duration of stay index [β = -5,4; P < 0.05]. Mean nursing hours/day was 7.6. p.27. **Each additional hour of nursing care/patient was associated with a decrease in expected LOS of 5.4%.**	**1** **1**

			17. In 131 New York hospitals, total nursing hours/patient day, adjusted for acuity, was inversely associated with mean hospital duration of stay index [β = -4.4; P < 0.05]. Mean nursing hours/day was 8.5. p.27. **Each additional hour of nursing care/patient was associated with a decrease in expected LOS of 4.4%.**	**1** **1**
			18. **In 76 Massachusetts hospitals, total nursing hours/patient, adjusted for acuity, was not associated with changes in LOS.** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.27	**0** **0**
Shamian 1994	Retrospective ? Low bias	1991? 58 1733	19. On cardiac step-down units, HWPPD was inversely, but not statistically, associated with LOS [mean LOS = 6.0 days; mean HWPPD = 7.2; P > 0.05; R^2 = 31%] p55. **An increase of 0.16 HWPPD (10 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **0**
			20. On medical-surgical units, HWPPD was inversely and statistically associated with LOS [mean LOS = 6.6 days; mean HWPPD = 6.3; P < 0.01; R^2 = 12%] p55-6. **An increase of 0.16 HWPPD (10 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
			21. On neurologic units, HWPPD was inversely and statistically associated with LOS [mean LOS = 6.6 days; mean HWPPD = 7.7; P < 0.01; R^2 = 22%] p55. **An increase of 0.23 HWPPD (14 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
			22. On oncology units, HWPPD was inversely and statistically associated with LOS [mean LOS = 7.9 days; mean HWPPD = 6.9; P < 0.01; R^2 = 10%] p55. **An increase of 0.17 HWPPD (10 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**

23. On orthopedic units, HWPPD was inversely and statistically associated with LOS [mean LOS = 6.1 days; mean HWPPD = 6.7. $P < 0.01$; R^2 = 37%] p55. **An increase of 0.29 HWPPD (17 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
24. On obstetrics units, HWPPD was inversely and statistically associated with LOS [mean LOS = 3.0 days; mean HWPPD = 3.0. $P < 0.01$; R^2 = 13%] p55. **An increase of 1.61 HWPPD (97 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
25. On pediatric units, HWPPD was inversely and statistically associated with LOS [mean LOS = 3.7 days; mean HWPPD = 9.7. $P < 0.01$; R^2 = 18%] p55. **An increase of 0.67 HWPPD (40 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
26. On psychiatric units, HWPPD was inversely and statistically associated with LOS [mean LOS = 12.5 days; mean HWPPD = 8.0; $P < 0.01$; R^2 = 20%] p55. **An increase of 0.25 HWPPD (15 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
27. On rehabilitation units, HWPPD was inversely and statistically associated with LOS [mean LOS = 24.8 days; mean HWPPD = 8.2; $P < 0.01$; R^2 = 47%]**.** p55. **An increase of 0.18 HWPPD (11 min PPD) was accompanied by a decrease in LOS of 1 day.**	**1** **1**
28. On neonatal units, HWPPD was *directly* and statistically associated with LOS [mean LOS = 14.0 days; mean HWPPD = 10.0; $P < 0.01$; R^2 = 9%] p55.	**(1)** **1**

Needle-man 2001	Retrospective 12 m Moderate bias	1997 799	29. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 significantly and consistently decreased the length of stay by between 3% and 6%.** [Rates ranged between 3.6 and 6.3 days. Relationship described as "strong and consistent."] p.101	**1 1**
			30. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on length of stay.** [Rates ranged between 3.9 and 8 days. Relationship described as "none."] p.101	**0 0**
			31. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 significantly and consistently decreased the length of stay by between 3% and 12%.** [Rates ranged between 3.6 and 6.3 days. Relationship described as ""strong and consistent."] p.101	**1 1**
			32. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on length of stay.** [Rates ranged between 3.9 and 8 days. Relationship described as "none."] p.101	**0 0**
Grillo-Peck 1995	Retrospective 12 m Moderate bias	1992-93 1 1 71	33. **Changing from a skill mix of 80% RN to 60% RN on a neuroscience unit (DRG 14: cerebrovascular disease) was not statistically associated with changes in duration of stay** [9.5 days vs 8.8 days; P = 0.5 for the 0.7-day difference]. p.370	**0 0**
Flood 1988	Retrospective 3 high bias	1988 1 2 . . .	34. **Mean DRG-adjusted LOS on the understaffed unit (78.5 8-h shifts not covered over 3 months) was longer than that on adequately staffed unit (45.5 extra 8-h shifts over 3 months)** [Mean understaffed = 9.1 days; mean adequate = 7.8 days; difference in means = 1.3days/patient; P not reported.] p.38	**1 0**

	35. **The understaffed unit (78.5 8-h shifts not covered over 3 months) had 9% more patient days beyond the mean hospital LOS than did the adequately staffed unit (45.5 extra 8-h shifts over 3 months).** [591 d/ 913 d = 65%; 448 d/ 799 d = 56%; difference = 9% more days above the mean LOS. P not reported.] p.39	**1 0**

Table 10. Summary of Studies on the Effects of Nurse Staffing on Testing, Treatment, and Procedure Errors

Study	.38.1 Internal Validity .39.1 External Validity Design Duration (m) Bias Age of Data # Hospitals # Units # Patients	.41.1 Effects on Testing, Treatment, and Procedure Errors	.42.1 Clinical Grade Statistical Grade
		1. Total hours of nursing care/patient day was not associated with medication error rates [β = + 0.50; P > 0.1. Mean rate = 11/10,000 doses; range, 0 to 26/10,000 doses]. p.48. **Although not statistically or clinically significant, each additional hour of nursing care/patient day was associated with an *additional* 0.5 of a medication error for each 10,000 doses given.**	**(0)** **0**
Blegen 1998 A	Retrospective 12 Low bias 1993 1 42 21,783	2. A richer RN skill mix, up to 88% RN, was statistically associated with lower rates of medication errors [β = -0.53; P < 0.05. Mean rate = 11/10,000 doses; range, 0 to 26/10,000 doses]. p.48. **Each 1% increase in RN skill mix, up to 88%, was associated with a decrease of 0.53 of a medication error in every 10,000 doses given.**	**?** **1**
		3. A richer RN skill mix above 88% RN was statistically associated with an increase in medication errors [β = +0.56, P < 0.05. Mean rate = 11/10,000 doses; range, 0 to 26/10,000 doses]. p.48. **Each 1% increase in RN skill mix above 88% was associated with an *increase* of 0.6 of a medication error in every 10,000 doses given.**	**(0)** **1**

Blegen 1998 B	Retrospective 30 high bias	1993-1995 11 39 . . .	4. An increase in the proportion of RN hours of care, up to 85%RN, was statistically associated with a decrease in the rate of medication errors/10,000 doses [β = -0.58; P < 0.05. Mean rate = 4.8/10,000 doses]. p.200. **The proportion of RN hours of care would have to be increased by about 2% to prevent one additional medication error for each 10,000 doses.**	**0** **1**
			5. An increase in the proportion of RN hours of care, up to 85% RN, was statistically associated with a small decrease in the rate of medication errors/1,000 patient days [β = -0.28; P > 0.05. Mean rate = 6.7/1,000 patient days]. p.200. **The proportion of RN hours of care would have to be increased by about 4%/patient day to prevent one additional medication error for each 1,000 patient days.**	**0** **0**
			6. An increase in the total hours of care/patient day (mean 10.8) was associated with an *increase* in the rate of medication errors/10,000 doses [β = 0.5; P < 0.05. Mean rate = 4.8/10,000 doses]. p.200. **An increase of 2 additional hours of care/patient day would result in one *additional* medication error/10,000 doses.**	**(0)** **1**
			7. An increase in the total hours of care/patient day (mean 10.8)was associated with an *increase* in the rate of medication errors/1,000 patient days [β = 0.32; P < 0.05. Mean rate = 6.7/1,000 patient days]. p.200. **An additional 3 hours of care/patient day would result in one *additional* medication error/1,000 patient days.**	**(1)** **1**
			8. An increase in the proportion of RN hours of care above 85% was associated with an *increase* in the rate of medication errors/10,000 doses [β = 0.48; P < 0.05. Mean rate = 4.8/10,000 doses]. p.200. **Above 85% RN hours of care, a 2% increase in RN hours of care would be associated with one *additional* medication error for each 10,000 doses.**	**(0)** **1**

			9. An increase in the proportion of RN hours above 85% was associated with an *increase* in the rate of medication errors/1,000 patient days [β = 0.23; P > 0.05. Mean rate = 6.7/1,000 patient days]. p.200. **Above 85% RN hours of care, a 4% increase in RN hours of care would be associated with one *additional* medication error for each 1,000 patient days.** *(Findings 6-9 above, are counter-intuitive and have not been replicated. Several possible explainations are provided by the author)*	**(0)** **0**
Grillo-Peck 1995	Retrospective 12 Moderate bias	1992-93 1 1 71	10. **Changing from a skill mix of 80% RN to 60% RN on a neuroscience unit (DRG 14: cerebrovascular disease) was not associated with the rate of medication errors** [7.2 vs. 6.8 errors/m; P = 0.75 for the difference of 0.4 errors/m]. p.370	**0** **0**
			11. **Changing from a skill mix of 80% RN to 60% RN on a neuroscience unit (DRG 14: cerebrovascular disease) was not associated with the rate of procedure errors** [4.8 vs. 5.0 errors/m; P = 0.9 for the difference of 0.2 errors/m]. p.370	**0** **0**
Taunton 1994	Retrospective 6 high bias	1990 4 65 . . .	12. **RN absenteeism (2.9 to 4.2 days lost/100 days scheduled) was not associated with medication error rates** [overall mean rate = 4.5; range, 0 to 17; data were not presented and were assumed to be clinically and statistically unremarkable.] p.54	**0** **0**
1992	Retrospective 12 high bias	1992 1 6 . . .	13. **"Nursing absenteeism" was not related to medication error rates.** The differences were not reported but were described as being not statistically significant. [P > 0.05].	**0** **0**

			14. RN hours/total daily nursing hours (mean = 52%) was not associated with medication error rates [β = -0.10; P > 0.05]. p.64. **Although not statistically or clinically significant, each additional RN hour of care/total daily nursing hours reduced the rate of medication errors by 0.10 errors/1,000 patient days over 3 months.**	**0** **0**
			15. LPN hours/total daily nursing hours (mean = 33%) was not associated with medication error rates [β = +0.06; P > 0.05] p.64. **Although not statistically or clinically significant, each additional LPN hour of care/total daily nursing hours increased the error rate by 0.06 errors/1,000 patient days over 3 months.**	**0** **0**
Wan 1987	Retrospective 3 Moderate bias	1985 45	16. RN hours/total daily nursing hours (mean = 52%) was not associated with testing or treatment error rates [β = 0.06; P > 0.05]. p.64. **Although not statistically or clinically significant, each additional RN hour of care/total daily nursing hours increased the rate of testing or treatment errors by 0.06 errors/1,000 patient days over 3 months.**	**0** **0**
			17. LPN hours/total daily nursing hours (mean = 33%) was not associated with testing or treatment errors [β = -0.04; P > 0.05]. p.64. **Although not statistically or clinically significant, each additional LPN hours of care/total daily nursing hours reduced the rate of testing or treatment errors by 0.04 errors/1,000 patient days over 3 months.**	**0** **0**
Dobal 1995	Cross-sectional 1 week Moderate bias	1994? 31 46 442 providers	18. **Nurse-to-patient ratios were not correlated with the rate of medication errors** [Mean ratio = 0.2, range, 0.05 to 0.3; mean error rate = 1.5; range, 0.2 to 4; r = 0.06; P > 0.05]. p.119	**0** **0**

.42.1.1 Effects On Errors in Intravenous Medication Administration

Wan 1987	Retrospective 3 Moderate bias	1985 45 … . . .	19. RN hours/total daily nursing hours (mean = 52%) was not associated with IV error rates [β = +0.17; P > 0.05]. p.64. **Although not statistically or clinically significant, each additional RN hour of care/total daily nursing hours *increased* the rate of IV errors by 0.17 errors/1,000 patient days over 3 months.**	**0 0**
			20. LPN hours/total daily nursing hours (mean = 33%) was not associated with IV error rates [β = +0.15; P > 0.05]. p.64. **Although not statistically or clinically significant, each additional LPN hour of care/total daily nursing hours *increased* the rate of IV errors by 0.15 errors/1,000 patient days over 3 months.**	**0 0**

Table 11. Summary of Studies on the Effects of Nurse Staffing on Other Complications

Study	.43.1 Internal .44.1 Validity / .45.1 External Validity Design Duration (m) Bias Age of Data # Hospitals # Units # Patients	.46.1 .47.1 Effects On Other Complications .49.1	.48.1 Clinical Grade Statistical Grade
Behner 1990	Retrospective 6 high bias 1989? 1 1 132	1. Staffing at 80% to 100% of recommended levels was associated with a complication rate of 18% (8/45); staffing at 60% to 80% was associated with a complication rate of 56% (28/50); and staffing below 60% was associated with a complication rate of 46% (7/37) [P < 0.01]. p.69. **Staffing rates closer to recommended levels were associated with decreased complication rates among surgical patients in the first 3 days of hospitalization.**	**1** **1**
		2. **Staffing at 80% or less of recommended levels was associated with a 30% increased probability of complications among surgical patients during entire hospital stay.** [P not reported]. p.69	**1** **0**
Flood 1988	Retrospective 3 high bias 1988 1 2 497	3. **The average complication rate on the understaffed unit (78.5 8-h shifts not covered over 3 months) did not differ from that of the adequately staffed unit (45.5 extra 8-h shifts over 3 months)** (1.9 vs 1.7 mean number of complications/patient; P not reported). p.38	**0** **0**
		4. **The understaffed unit (78.5 8-h shifts not covered over 3 months) had 7% more patients with complications than did the adequately staffed unit (45.5 extra 8-h shifts over 3 months)** [71% (185/259) vs 64% (152/238); P not reported]. p.38	**1** **0**

Silber 1995	Retrospective 12 low bias	1992 57 . . . 16,673	5. **For patients undergoing cardiac bypass surgery, higher nurse-to-bed ratios were statistically associated with *higher* complication rates** [RR = 1.09; 95%CI = 1.05 to 1.13; P < 0.001. The relative risk of complications was 0.09 *higher* for the next highest quartile of nurse-to-bed ratios] p. 321	**0 1**
Kovner 1998	Cross-sectional 12 Moderate bias	1993 506	6. **The number of RN FTEs/patient day was not associated with complications caused by medical or diagnostic equipment** [Data were not presented and so were presumed to be not clinically relevant or statistically significant.] p. 316	**0 0**

.49.1.1 Effects on Venous Thrombosis

Needle-man 2001	Retrospective 12 m moderate bias	1997 799	7. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 had no or inconsistent effects on deep vein thrombosis.** [Rates ranged from 0.3% to 0.6%. Relationship described as "none/inconsistent."] p.101	**0 0**
			8. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no or inconsistent effects on deep vein thrombosis.** [Rates ranged from 0.2% to 0.8%. Relationship described as "none."] p.101	**0 0**
			9. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 had no or inconsistent affect on the rate of deep vein thrombosis.** [Rates ranged from 0.3% to 0.6%. Relationship described as "none/ inconsistent."] p.101	**0 0**
			10. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no or inconsistent affect on the rate of deep vein thrombosis.** [Rates ranged from 0.2% to 0.8%. Relationship described as "none."] p.101	**0 0**
Kovner 1998	Cross-sectional 12 Moderate bias	1993 506	11. **Increases in RN FTEs were statistically associated with decreases in the rate of thrombosis after major surgery.** [Mean rate = 0.4/100 discharges, range 0 to 4; β = -33.22; 95%CI = -57.76 to –8.68; P < 0.01.] Unable to interpret the clinical importance of the finding. p.319	**? 1**
			12. **Increases in non RN FTEs were statistically and inversely associated with decreases in thrombosis after major surgery.** [Mean rate = 0.4/100 discharges, range 0 to 4; β = -11.7; P < 0.007.] Unable to interpret the clinical importance of the finding. p.318	**? 1**
			13. **Increases in RN FTE and non RN FTE were apparently not associated with the rates of venous thrombosis after invasive vascular procedures.** [Data were not presented and so were presumed to be not clinically relevant or statistically significant.] p.316	**0 0**

.49.2.1 Effects on Shock

.49.3.1 Needleman 2001	Retrospective 12 m moderate bias	1997 799	14. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 decreased the rate of shock by between 6% and 10%.** [Rates ranged from 0.1% to 0.8%. Relationship described as "strong."] p.101	**1 1**
			15. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on the rate of shock.** [Rates ranged from 0.1% to 1.6%. Relationship described as "none."] p.101	**0 0**
			16. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 decreased the rate of shock by between 7% and 13%.** [Rates ranged from 0.1% to 0.8%. Relationship described as "strong."] p.101	**1 1**
			17. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on the rate of shock.** [Rates ranged from 0.1% to 1.6%. Relationship described as "none."] p.101	**0 0**

.49.4.1 Effects on Pulmonary Compromise

Needleman 2001	Retrospective 12 m moderate bias	1997 799	18. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on pulmonary failure rates.** [Rates ranged from 0.2% to 2.2%. Relationship described as "none."] p.101	**0 0**
			19. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on pulmonary failure rates.** [Rates ranged from 0.2% to 2.2%. Relationship described as "none."] p.101	**0 0**
Kovner 1998	Cross-sectional 12 moderate bias	1993 506	20. Increases in RN FTE were associated with decreases in the rate of pulmonary compromise after major surgery. [Mean rate = 0.9/100 discharges, range 0 to 18; $\beta = -59.69$; $P < 0.05$] p.319. **"An increase of 0.5 RN h/patient day was associated with a 1.8% decrease in the rate of pulmonary compromise after surgery."**	**0 1**

.49.4.1.1 Effects On Gastrointestinal Hemorrhage

			21. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 decreased the rate of upper gastrointestinal hemorrhage by between 5% and 7%.** [Rates ranged from 0.5% to 1.2%. Relationship described as "consistent."] p.101	**0** **1**
Needle-man 2001	Retrospective 12 m moderate bias	1997 799	22. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 had no effect on rates of gastrointestinal hemorrhage.** [Rates ranged from 0.3% to 1.6%. Relationship described as "none."] p.101	**0** **0**
			23. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 "consistently" decreased the rate of upper gastrointestinal hemorrhage by between 3% and 17%.** [Rates ranged from 0.5% to 1.2%. Relationship described as "consistent."] p.101	**1** **1**
			24. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 had no effect on rates of gastrointestinal hemorrhage.** [Rates ranged from 0.3% to 1.6%. Relationship described as "none."] p.101	**0** **0**
Kovner 1998	Cross-sectional 12 Moderate bias	1993 506	25. **Changes in RN FTE were not associated with the rate of gastrointestinal hemorrhage after major surgery.** [Data were not presented and so were presumed to be not clinically relevant or statistically significant.] p.316	**0** **0**

.49.4.1.2 Effects On Rate of Acute Myocardial Infarction

Kovner 1998	Cross-sectional 12 Moderate bias	1993 506	26. **Changes in RN FTE were not associated with the rate of acute myocardial infection.** [Data were not presented and so were presumed to be not clinically relevant or statistically significant.] p.316	**0** **0**

.49.5.1 Effects On Rate of Cardiac Arrests

Blegen 1998 B	Retrospective 30 high bias	1993-1995 11 39 . . .	27. Total hours of nursing care (mean = 10.8) was not associated with the rate of cardiac arrests/1,000 patient days [β = -0.1; P > 0.1. Mean rate = 1.6/1,000 patient days]. p.200. **Although not statistically or clinically significant, each additional hour of care/patient day was associated with a decrease of 0.1 cardiac arrest/1,000 patient days.**	**0 0**
			28. The proportion of care delivered by RNs (mean = 73%) was not associated with the rate of cardiac arrests/1,000 patient days [β = -0.08 P > 0.1. Mean rate = 1.6/1,000 patient days]. P. 200. **Although not statistically or clinically significant, each additional percent of care provided by an RN prevents about 0.1 cardiac arrest/1,000 patient days.**	**0 0**

.49.6.1 Effects On Patient Morbidity

Bradbury 1994	Retrospective 12 high bias	1990 43	29. **Mean total FTEs did not differ significantly between hospitals in the highest and lowest quartiles of major morbidity,** where morbidity was defined as remaining in the two highest severity groups for 1 week [719 vs 776 FTEs; P > 0.05]. p.64	**? 0**
			30. **Mean total staff/admission ratios did not differ significantly between hospitals in the highest and lowest quartiles of major morbidity,** where morbidity was defined as remaining in the two highest severity groups for 1 week [0.096 vs 0.103; P > 0.05]. p.64	**0 0**

31. **Mean RN/LPN ratios did not differ significantly between hospitals with the highest and lowest quartiles of major morbidity,** where morbidity was defined as remaining in the two highest severity groups for 1 week [5.5 vs 4.8; P > 0.05]. p.64	**0**	**0**

.49.7.1 Effects on Failure to Rescue (Death after Complications)

.49.8.1 e e d l e - m a n 2001	Retrospective 12 m moderate bias	1997 799	32. **In medical patients, increasing mean RN hours/day from 6.4 to 9.1 had inconsistent effects on failure-to-rescue rates.** [Rates ranged from 13.6% to 22.6%.] p.101	**0 0**
			33. **In surgical patients, increasing mean RN hours/day from 6.4 to 9.1 decreased failure-to-rescue rates by between 4% and 6%.** [Rates ranged from 13% to 22.6%. Relationship described as "strong/consistent."] p.101	**1 1**
			34. **In medical patients, increasing mean total nursing hours/day from 9.7 to 13 had inconsistent effects on failure-to-rescue rates (death after complications).** [Rates ranged from 0.3% to 1.6%.] p.101	**0 0**
			35. **In surgical patients, increasing mean total nursing hours/day from 9.7 to 13 decreased failure-to-rescue rates by between 2% and 12%.** [Rates ranged from 13% to 22.6%. Relationship described as "strong/consistent."] p.101	**1 1**

Effects On Patient Injuries (Not Specified)

Wan 1987	Retrospective 3 Moderate bias	1985 45	36. RN hours/total daily nursing hours (mean = 52%) was not associated with injury rates [β = +0.25 P > 0.05]. p.64. **Although not statistically or clinically significant, each additional RN hour of care/total daily nursing hours *increases* the injury rate by 0.25 injuries/1,000 patient days over 3 months.**	**(0) 0**
			37. LPN hours/total daily nursing hours (mean = 33%) was not associated with injury rates [β = +0.33 P > 0.05]. p 64. **Although not statistically or clinically significant, each additional LPN hour of care/total daily nursing hours *increases* the injury rate by 0.33 injuries/1,000 patient days over 3 months.**	**(0) 0**

Table 12. Summary of Studies on the Effects of Nurse Staffing on Patient Satisfaction and Perceptions of Care

Study	.1.1 Internal .2.1 Validity / Design / Duration (m) / Bias	.3.1 External Validity / Age of Data / # Hospitals / # Units / # Patients	.4.1 Effects On Patient Satisfaction and Perceptions of Care	.5.1 Clinical Grade / Statistical Grade
Sovie 2000	Prospective 36 Low bias	1997 & 1998 29	1 & 2. The number of RN hours worked/patient day (range 3 to 10 h) was directly and statistically associated with satisfaction with pain management (range 80% to 95%) on medical and surgical units [β = 1.43, value computed from graph; P < 0.001]. **Each increase of 7 Rn HWPPD resulted in a 10% improvement in satisfaction with pain managem, on both types of units**; satisfaction was significantly higher on medical units [difference = 5%; P = 0.02]. p.69	**0** **1** **0** **1**
Bostrom .6.1 1993	Prospective 9 Moderate bias	1993 1 3 . . .	3. **The 17% reduction in staff RN minutes/patient/shift (16 min, from 96 to 80 min) after moving to team nursing did not affect patient satisfaction scores.** [All means = 1 or 2 on 5-point scale, 1 = good.] p.39	**0** **0**

			4. **Nursing model (skill mix) had no significant effect on quality of patient care (as measured by trained raters on the QualPaC Scale).** On a 5-point scale, the rating was 3.3 on the Primary Nursing unit (100% RN), 3.0 on the Modular Nursing unit (50% RN/ 50% LPN), and 3.1 on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP) [P = 0.2]. p.180	**0** **0**
Shukla 1983	Prospective 10 Low bias	1983 1 3 . . .	5. **Nursing model (skill mix) had no significant effect on nurses' perception of quality of care (Safford Scale).** On a 5-point scale, the rating was 3.5 on the Primary Nursing unit (100% RN), 3.8 on the Modular Nursing unit (50% RN/ 50% LPN), and 3.7 on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP) [P = 0.33]. p.180	**0** **0**
			6. **Nursing model (skill mix) had a significant effect on the quality of clinical care (Clinical Care Quality Index for meeting IV administration standards).** On a scale of 1% to 100%, the index was 57% on the Primary Nursing unit (100% RN), 58% on the Modular Nursing unit (50% RN/ 50% LPN), and 69% on the Team Nursing unit [P = 0.001 for the difference between Primary and Team units]. p.180	**(1)** **1**
			7. **Nursing model (skill mix) had no significant effect on physicians' perception of quality of care (Safford Scale).** On a 5-point scale, the rating was 4.0 on the Primary Nursing unit (100% RN), 3.8 on the Modular Nursing unit (50% RN/ 50% LPN), and 4.0 on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP) [P = 0.34]. p.180	**0** **0**
Hinshaw 1981	Prospective 10 high bias	1976 1 1 . . .	8. **Nurses' perceptions of quality of care did not change as nursing model changed from a team model to all-RN staffing.** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.33	**0** **0**

			9. **Patients' perceptions of quality of care did not change as nursing model changed from a team model to all-RN staffing.** [Data were not reported and so were assumed to be clinically and statistically unremarkable]. p.33	**0** **0**
			10. **After changing from a team model of nursing to all-RN staffing, patient (n = 50) perceptions of technical care improved statistically but not substantively** [4.1 vs 4.3 on a 5-point scale; P < 0.001]. p.33	**0** **1**
			11. **After changing from a team model of nursing to all-RN staffing, patient (n = 50) perceptions of trust in nurses improved statistically but not substantively** [4.1 vs 4.3 on a 5-point scale; P < 0.001]. p.33	**0** **1**
			12. **After changing from a team model of nursing to all-RN staffing, patient (n = 50) perceptions of RN teaching quality did not change** [4.0 vs 4.0; P < 0.001]. p.33	**0** **1**
Blegen 1998 A	Retrospective 12 Low bias	1993 1 42 21,783	13. Total hours of nursing care/patient was not related to the rate of complaints [β = 0.47; P > 0.05. Mean rate = 2.2/1,000 patient days; range, 0 to 11/1,000 patient days] Each additional hour of nursing care was associated with a decrease of about 0.5 complaints/ 1,000 patient days. p.48. **Although not statistically or clinically significant, about 2 additional hours of nursing care/patient day would be required to prevent 1 additional complaint in each 1,000 patient days.**	**0** **0**
			14. RN skill mix was not associated with an increase in the rate of complaints [β = +0.31; P > 0.05. Mean rate = 2.2/1,000 patient days; range, 0 to 11/1,000 patient days]. p.48. **Although not statistically or clinically significant, each 10% increase in RN skill mix was associated with an *increase* of about 3 complaints for each 1,000 patient days.**	**(0)** **0**
Dobal 1995	Cross-sectional 0.25 Moderate	1994? 31 46	15. **Nurse-to-patient ratios accounted for 18.5% of the variance in nurses' perceptions of their ability to meet family needs** [r = 0.43; r^2 = 0.185; P < 0.01]. p.119	**?** **1**

bias	442 providers	16. **Nurse-to-patient ratios accounted for 9% of the variance in patients' perceptions of the supporting behaviors of nurses** [r = 0.30; r^2 = 0.09; P > 0.05]. p.119	**? 0**

Table 13. Summary of Studies on the Effects of Nurse Staffing on Patient Care Monitoring

Study	.7.1 Internal .8.1 Validity Validity Design Duration (m) Bias	.9.1 External Validity Age of Data #Hospitals # Units # Patients	.10.1 Effects on Patient Care Monitoring	.11.1 Clinical Grade Statistical Grade
			1. A lower LPN/RN ratio (a richer RN skill mix) was associated with higher care plan index (CPI) scores (higher quality care plans) [Range 39% to 97%; β = -6.39%; P not reported but presumed to < 0.05]. p.341. **For each unit increase in the LPN/RN ratio (representing a leaner skill mix), the CPI index dropped 6.4% on a 100% scale**.	**1** **1**
Carter ***.12.1 1986***	Prospective 96 Low bias	1977-85 1 12 . . .	2. A lower LPN/RN ratios (a richer RN skill mix) was associated with higher nursing record index (NRI) scores (better documentation of care) [Range 25% to 98%; β = -9.71; P not reported but presumed to be < 0.05]. p.341. **For each unit increase in the LPN/RN ratio (representing a leaner skill mix), the NRI index dropped 9.7% on a 100% scale.**	**1** **1**
			3. A lower LPN/RN ratios (a richer RN skill mix) was associated with higher nursing care index (NCI) scores (better quality care) [Range 9% to 100%; β = -4.64; P not reported but presumed to be < 0.05]. p.341. **For each unit increase in the LPN/RN ratio (representing a leaner skill mix), the NCI index dropped 4.7% on a 100% scale.**	**1** **1**

			4. **"Nursing absenteeism" was not related to medication errors.** [The rates were not reported but were described as being not statistically significant]. p.38	**0** **0**
			5. **"Nursing absenteeism" was not related to rates of adherence to environmental regulations.** [The rates were not reported but were described as being not statistically significant]. p.38	**0** **0**
Ceria 1992	Retrospective 12 high bias	1989 1 6 . . .	6. **"Nursing absenteeism" was not related to errors in IV monitoring.** [The rates were not reported but were described as being not statistically significant]. p.38	**0** **0**
			7. **"Nursing absenteeism" was not related to care plan monitoring.** [The rates were not reported but were described as being not statistically significant.] p.38	**0** **0**
			8. **"Nursing absenteeism" was not related to errors in crash cart monitoring.** [The rates were not reported but were described as being not statistically significant.] p.38	**0** **0**

Table14. Summary of Studies on the Effects of Nurse Staffing on Nursing Documentation

Study	.13.1 Internal Validity .14.1 / .15.1 External Validity Design Duration (m) Bias Age of Data # Hospitals # Units # Patients	.16.1 Effects on Nursing Documentation	.17.1 Clinical Grade Statistical Grade
Bostrom .18.1 1993	Prospective 9 Moderate bias	1. **The 17% reduction in staff RN minutes/patient/shift (16 min, from 96 to 80 min) after moving to team nursing was not associated with changes in the number of incident reports** [maximum change in ratio of unit-to-hospital incident report frequencies for 3 nursing units = 0.2/1,000. Minimum ratio = 0.4 before reduction; maximum ratio = 1.3 after reduction. P not reported.] p.40	**(1)** **0**
Hinshaw 1981	Prospective 10 High bias	2. **Changing from a team model of nursing to all-RN staffing was accompanied by an increase in the number of documented patient problems per Kardex** [mean = 1 patient problem/Kardex before vs. 2.43 patient problems/Kardex after; P < 0.001]. p.34	**1** **1**

Kuhn 1991	Retrospective 12 high bias	1991 1219	3. **In California, a higher proportion of RNs/nursing staff (overall mean = 67% RN) was associated with lower physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 3.58%, best quartile = 2.30%; P < 0.001. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**1 1**
			4. **In New York, a higher proportion of RNs/nursing staff (overall mean = 63% RN) was statistically associated with higher physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 1.04, best quartile = 1.60; P < 0.05. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**1 1**
			5. **In Pennsylvania, a higher proportion of RNs/nursing staff (overall mean = 66% RN) was associated with lower physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 3.61, best quartile = 2.33; P < 0.01. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**1 1**
			6. **In Ohio, a higher proportion of RNs/nursing staff (overall mean = 61%) was associated with lower physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 0.97, best quartile = 0.81; P > 0.05. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**0 0**

			7. **In Illinois, a higher proportion of RNs/nursing staff (overall mean = 65%) was associated with lower physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 6.85, best quartile = 3.32; P < 0.01. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**1** **1**
			8. **In Texas, a higher proportion of RNs/nursing staff (overall mean = 52%) was associated with lower physician-confirmed problem rates in quality of care reviews of Medicare charts** [worst quartile = 4.04, best quartile = 3.94; P < 0.05. Means for all states were 3.45%, lowest quartile and 2.53% highest quartile]. p.1033	**0** **1**
Ceria 1992	Retrospective 12 High bias	1989 1 6 . . .	9. **"Low absenteeism" "was associated" with lower rates of incident reports and higher rates of adherence to environmental and IV monitoring protocols**. The differences were not reported but were described as being not statistically significant [P > 0.05].	**0** **0**
			10. **"High absenteeism" "was associated" with *better* adherence to crash cart monitoring protocols**. The differences were not reported but were described as being not statistically significant [P > 0.05].	**(0)** **0**

Table 15. Summary of Studies on the Effects of Nurse Staffing on Nursing Absenteeism, Turnover, and Vacancy Rates

.18.1.1.1	*.19.1 Internal* *.20.1 Validity* *.21.1 External* **Validity** **Design** **Duration (m)** **Bias**	**Age of Data** **# Hospitals** **# Units** **# Patients**	*.22.1 Effects On Nursing Absenteeism, Turnover, and Vacancy rates*	*.23.1 Clinical Grade* **Statistical Grade**
Bloom 1992	Retrospective 12 Moderate bias	1980 435	1. Nurse-to-bed ratios (mean = 0.003, or 1 RN/333 beds) were directly correlated with RN turnover rates (% of RNs voluntarily resigning from unit/quarter; mean = 26%; data highly skewed) [β = +0.25; P < 0.001]. p.1420. **An additional 10% beds per RN was associated with a 2.5% increase in resignations per unit/quarter.**	**(?) 1**
Dobal 1995	Cross-sectional 0.25 Moderate bias	1994? 31 46 442 providers	2. **Nurse-to-patient ratios were not correlated with position vacancy rates** [Mean vacancy rate = 7.9%; r = 0.14; P > 0.05]. p.119	**0 0**
			3. **Nurse-to-patient ratios were not correlated with turnover rates** [Mean turnover rate = 19.3%; r = -0.16; P > 0.05]. p.119	**0 0**

Table16. Summary of Studies on the Effects of Nurse Staffing on Nurse Satisfaction

.23.1.1.1	*.24.1 Internal* *.25.1 Validity* *.26.1 External* **Validity** **Design** **Duration (m)** **Bias**	**Age of Data** **#** **Hospitals** **# Units** **# Patients**	*.27.1 Effects On Nurse Satisfaction*	*.28.1 Clinical Grade* **Statis-tical Grade**
Hinshaw 1981	Prospective 10 high bias	1976 1 1 . . .	1. **Changing from a team model of nursing to all-RN staffing was accompanied by improved job satisfaction among nurses** [mean satisfaction increased from 2.97 (n = 18) to 3.52 (n = 17) on a 5-point scale; P < 0.001]. p.32	**0 1**
			2. **Changing from a team model of nursing to all-RN staffing was accompanied by improved group cohesion among nurses** [mean cohesion 2.43 (n = 18) to 3.1 (n = 17) on a 5-point scale; P = 0.055]. p.32	**? 1**

Table 17. Summary of Studies on the Effects of Nurse Staffing on Other Aspects of Nursing

Study	.29.1 Internal .30.1 Validity / Design Duration (m) Bias	.31.1 External Validity / Age of Data # Hospitals # Units # Patients	.32.1 Effects on Other Aspects of Nursing	.33.1 Clinical Grade / Statistical Grade
Hinshaw 1981	Prospective 10 high bias	1976 1 1 . . .	1. **After changing to all RN staffing, the criteria used by RNs to define the quality of nursing became "more professional."** The effect is described as a shift from using more personal to more professional criteria. [P not reported]. p.32	**0 0**
		.34.1 Effects On Assaults on Psychiatric Nursing Staff		
Lanza 1997	Prospective 6 low bias	1997 1 6 3,312 shifts	2. **Assault rate was not related to the number of patients.** [Data were not reported but were described as indicating no relationship.] p.45	**0 0**
			3. **Assault rate was not related to the number of RNs.** [Data were not reported but were described as indicating no relationship.] p.45	**0 0**
			4. **Assault rate was not related to the number of LPNs.** [Data were not reported but were described as indicating no relationship.] p.45	**0 0**
			5. **Assault rate was not related to the number of UAPs.** [Data were not reported but were described as indicating no relationship.] p.45	**0 0**

6. **Assault rate was not related to the number of total staff.** [Data were not reported but were described as indicating no relationship.] p.45	**0** **0**
7. **Assault rate was not related to the patient/staff ratio.** [Data were not reported but were described as indicating no relationship.] p.45	**0** **0**

Table 18. Summary of Studies on the Effects of Nurse Staffing on Amount of Direct Nursing Care

.34.1.1.1	*.35.1* *Internal* *.36.1* *Validity*	*.37.1* *External* **Validity**	*.38.1* *Effects On Amount of Direct Nursing Care*	*.39.1* *Clinical Grade*
	Design **Duration (m)** **Bias**	**Age of Data** **# Hospitals** **# Units** **# Patients**		**Statistical Grade**
Shukla 1983	Prospective . . . Low bias	1983 1 3 . . .	1. **Nursing model (skill mix) had no significant effect on the amount of direct care in hours/patient day.** The mean amount was 0.94 h/d on the Primary Nursing unit (100% RN), 1.05 h/d on the Modular Nursing unit (50% RN/ 50% LPN), and 0.95 h/d on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP) [P not reported] p.182	**0** **0**
			2. **Nursing model (skill mix) had no significant effect on the proportion of time an RN spent in direct care.** The rate was 37.5% on the Primary Nursing unit (100% RN), 40.8% on the Modular Nursing unit (50% RN/ 50% LPN), and 41.5% on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP). [P not reported] p.182	**0** **0**

Arndt 1998	Retrospective . . . Moderate bias	1998 5	3. A greater proportion of care delivered by RNs was statistically associated with lower hours of care/patient for patients undergoing inguinal and femoral hernia operations (DRG 162; n = 195) [β = -0.14; P < 0.01]. **For each additional hour of care provided by an RN, the total hours of care received by a patient in DRG 162 *dropped* by 0.14 of an hour, or about 9 minutes** (0.14 of 60 min = 9 min). p.43	**(0) 1**
			4. A greater proportion of care delivered by RNs was associated with higher hours of care/patient for patients with esophageal, gastro-intestinal and digestive disorders (DRG 183; n = 295)**.** [β = 0.08; P > 0.05] **For each additional hour of care provided by an RN, the total hours of care received by a patient in DRG 183 increased by 0.08 of an hour, or about 5 minutes** (0.08 of 60 min = 5 min). p.43	**? 0**
			5. A greater proportion of care delivered by RNs was statistically associated with higher hours of care/case for non-radical hysterectomy (DRG 355; n = 235). [β = 0.20; P < 0.01] **For each additional hour of care provided by an RN, the total hours of care received by a patient in DRG 355 increased by 0.20 of an hour, or about 12 minutes** (0.20 of 60 min = 12 min). p.44	**0 1**
			6. A greater proportion of care delivered by RNs was statistically associated with higher hours of care/case for medical back problems (DRG 243; n = 407) [β = -0.05; P < 0.05]. **For each additional hour of care provided by an RN, the total hours of care received by a patient in DRG 243 increased by 0.08 of an hour, or about 5 minutes** (0.08 of 60 min = 5 min). p.44	**0 1**

Table 19. Summary of Studies on the Effects of Nurse Staffing on Institutional Financial Outcomes

.39.1.1.1	*.40.1 Internal* *.41.1 Validity*	*.42.1 External* **Validity**	*.43.1 Effects On Institutional Financial Outcomes*	*.44.1 Clinical Grade*
	Design Duration (m) Bias	**Age of Data # Hospitals # Units # Patients**		**Statis-tical Grade**
Sovie 2000	Prospective 36 Low bias		1. **On medical units, skill mix (% RN) was not correlated with regional adjusted labor costs/discharge** [r = -0.07; P = 0.77]. p.62	**0 0**
		1997 29	2. **On surgical units, skill mix (% RN) was not correlated with regional adjusted labor costs/discharge** [r = -0.07; P = 0.78]. p.62	**0 0**
			3. **RN HWPPD was not correlated with regional adjusted labor costs/discharge** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.62	**0 0**
		1998 29	4. **On medical units, skill mix (% RN) was not correlated with regional adjusted labor costs/discharge** [r = -0.18; P = 0.38]. p.62	**0 0**
			5. **On surgical units, skill mix (% RN) was not correlated with regional adjusted labor costs/discharge** [r = -0.11; P = 0.60]. p.62	**0 0**

			6. **RN HWPPD was not correlated with regional adjusted labor costs/discharge** [Data were not reported and so were assumed to be clinically and statistically unremarkable.] p.62	**0** **0**
Shukla 1983	Prospective 10 Low bias	1983 1 3 . . .	7. **Nursing model (skill mix) had no significant effect on** total cost/patient day**.** The mean cost was $22.12 on the Primary Nursing unit (100% RN), $21.59 on the Modular Nursing unit (50% RN/ 50% LPN), and $20.19 on the Team Nursing unit (50% RN/ 25% LPN/ 25% UAP). [P not reported] p.180	**0** **0**
Hinshaw 1981	Prospective 10 high bias	1976 1 1 . . .	8. **After changing from a team model of nursing to all RN staffing, mean hours/day of nursing sick leave dropped from 1.24 to 0.48 h/day.** [P not reported]. p.35	**1** **0**
			9. **After changing from a team model of nursing to all RN staffing, mean hours/day of overtime dropped from 0.79 to 0.39 h/day.** [P not reported]. p.35	**1** **0**
			10. **After changing from a team model of nursing to all RN staffing, mean hours/day of compensatory time off dropped from 0.28 to 0.04 h/day.** [P not reported]. p.35	**1** **0**
Bostrom ***.45.1 1993***	Prospective 9 Moderate bias	1993 1 3 . . .	11. **The 17% reduction in staff RN minutes/patient/shift (16 min, from 96 to 80 min) after moving to team nursing lowered average acuity–adjusted costs per patient day by $8, $13, and $88 on the three nursing units** [P not reported]. p.39	**1** **0**
Behner 1990	Retrospective 6 high bias	? < 1989 1 1 132	12. **The additional costs of 132 patients in DRG 215 (back and neck procedures) experiencing complications was greater than the savings achieved by 20% understaffing of RNs** [costs of complications = $30,800; savings from understaffing = $13,600; surplus from full staffing = $17,200; P not reported]. p.70	**1** **0**

Flood 1988	Retrospective 3 high bias	1988 1 2 . . .	13. **The understaffed unit (78.5 8-h shifts not covered over 3 months) lost an estimated $151,000/year more than did the adequately staffed unit (45.5 extra 8-h shifts over 3 months)** ($-236,000 vs $-85,000; 1985 dollars; P not reported). p.39	**1 0**
Glandon 1989	Retrospective 3 Moderate bias	1987 62 392 . . .	14. **Primary care nursing (24-h RN accountability; 75% RN) was more expensive than team (58% RN), modular (60% RN), and total patient care (71% RN) models of nursing.** Adjusted nursing costs/unit workload (for a standardized patient) were $2.80 (6.3%) above the overall study average of $44.02 [P not reported]. p.32	**1 0**
			15. **Team nursing (nurse coordinates team; 58% RN)) was less expensive than primary care (75% RN), modular (60% RN), and total patient care (71% RN) models of nursing.** Adjusted nursing costs/unit workload (for a standardized patient) were $2.09 (4.7%) below the overall study average of $44.02 [P not reported]. p.32	**1 0**
			16 **Nursing units with more than 70% RN staffing were more expensive than units with less than 70% RN staffing.** Adjusted nursing costs/unit workload (for a standardized patient) were $2.60 (5.9%) above the overall study average of $44.02 [P not reported]. p.32	**1 0**
			17. **Nursing units with less than 61% RN staffing were less expensive than units with more than 61% RN staffing.** Adjusted nursing costs/unit workload (for a standardized patient) were $3.28 (7.5%) below the overall study average of $44.02 [P not reported]. p.32	**1 0**
Hallora n 1983	Prospective 0.5 High	1983? 1 2 103	18. **The unit with 72% RN staffing cost less and delivered more effective care than a similar unit with 40% RN, 20% LPN, and 40% UAPs** [$280 (1.68 h/day) vs. $305 (1.3 h/day); P value for the $25/day difference not reported. Effective care was defined by correlations between total hours of direct care and time spent with each patient in each of Maslow's five Hierarchy of Needs categories]. p.22	**1 0**

Osinski 1980	Cross-sectional 1 day High	1980 35	19. **The hospital using all-RN staffing had the lowest nursing care hours** [2.6 vs. 4.0 h/d for those using primary nursing, 4.3 h/d for those using team nursing, 3.9 h/d for those using functional nursing, and 4.8 h/d for those using team-functional nursing. P not reported]. p.21	**(1)** **0**
			20. **The hospital using all-RN staffing had the lowest cost per bed per day** [$18.64 vs. $23 for those using primary nursing, $23.50 for those using team nursing, $24.25 for those using functional nursing, and $24.36 for those using team-functional nursing. P not reported]. p.20	**1** **0**

Table 20. Summary of All Findings from Studies on the Effects of Nurse Staffing Level, by Clinical and Statistical Grades

(**Clinical grades**: 1 = positive finding; 0 = negative finding; ? = uninterpretable finding; ( ) = counter-intuitive finding;

Statistical grades: 0 = P > 0.05; 1 = P < 0.05. Entries in boldface were published in 1995 or later.)

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
3. Nosocomial Infections	6	10	Shukla 83 **(Blegan 98A)** **Blegan 98A** **ANA 97** **ANA 97** **(Grillo 95)**			Taunton 94		**ANA 97** **ANA 97** Haley 82
4. Urinary Tract Infections	4	16	**Sovie 00** **Sovie 00** **Sovie 00** **Sovie 00** **Sovie 00** **ANA 97**			**Needleman 01** **Kovner 98**	**Sovie 00** **Needleman 01** **Kovner 98**	**ANA 97** **ANA 97** **ANA 97** **Needleman 01** **Needleman 01**

5. Pneumonia	3	11	**ANA 97** **ANA 97** **Kovner 98**	**Kovner 98**	**ANA 97** **ANA 97** **Needleman 01** **Needleman 01** **Needleman 01** **Needleman 01** **Kovner 98**

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
6. Falls	10	18	**Arbesman 99** **Blegan 89A** **Blegan 89A (Blegan 89A)** **Blegan 89B** **Dobal 95** Kustaborder 85 Kustaborder 85 Taunton 94 Ceria 92 Wan 87 Wan 87		**Sovie 00** **Sovie 00**		**Sovie 00** **Sovie 00**	**Blegan 89B (Grillo 95)**

7. Pressure Ulcers	4	19	**Sovie 00** **Sovie 00** **Sovie 00** **ANA 97** **ANA 97** **Needleman 01** **Needleman 01** **Needleman 01** **Needleman 01** **(Blegan 98A)**	**(Blegan 98A)**	**Sovie 00**	**ANA 97** **ANA 97** **ANA 97** **ANA 97** **ANA 97** **ANA 97** **Blegan 98A**

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
8. In-hospital mortality	11	28	**Robertson 99** **Robertson 99** **Robertson 99** **Silber 95** **Silber 95** **Needleman 01** **Needleman 01** **Needleman 01** **Needleman 01** Bradbury 94 Bradbury 94 Shortell 88	**(Silber 95)**	**(Blegan 98A)** **(Blegan 98A)** **Blegan 98A** Bradbury 94 Manheim 92	**Bond 99** **Bond 99** **Aiken 00**		**Aiken 00** Manheim 92 Hartz 89 Hartz 89 Hartz 89 Krakauer 91 Krakauer 91

9. Length of Stay	6	35	**Sovie 00** **Sovie 00** **Sovie 00** **ANA 97** **Needleman 01** **Needleman 01** **Grillo 95**		Shamian 94 Flood 88 Flood 88	**Sovie 00** **Sovie 00** **ANA 97** **ANA 97** **ANA 97** **ANA 97** **ANA 97** **ANA 97** **ANA 97**	**Sovie 00**	**ANA 97** **ANA 97** **ANA 97** **ANA 97** **Needleman 01** **Needleman 01** Shamian 94 Shamian 94 Shamian 94 Shamian 94 Shamian 94 Shamian 94 Shamian 94 Shamian 94 (Shamian 94)

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
10. Errors	6	20	**(Blegan 98A)** **Blegan 98B** **(Blegan 98B)** **Grillo 95** **Grillo 95** **Dobal 95** Taunton 94 Taunton 94 Wan 87 Wan 87 Wan 87 Wan 87 Wan 87 Wan 87			**Blegan 98A** **Blegan 98B** **(Blegan 98B)** **(Blegan 98B)**	**Blegan 98A**	**(Blegan 98B)**

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
11. Other Complications Unspecified Complications	4	6	Flood 88 **Kovner 98**		Behner 90 Flood 88	**Silber 95**		Behner 90
Venous Thrombosis	2	7	**Needleman 01** **Needleman 01** **Needleman 01** **Needleman 01** **Kovner 98**				**Kovner 98** **Kovner 98**	
Schock	1	4	**Needleman 01** **Needleman 01**					**Needleman 01** **Needleman 01**

Pulmonary Compromise	2	3	**Needleman 01 Needleman 01**			**Kovner 98**		
Gastrointestinal Hemorrhage	2	4	**Needleman 01 Needleman 01 Kovner 98**			**Needleman 01**		**Needleman 01**
Myocardial Infarction	1	1	**Kovner 98**					
Cardiac Arrests	1	2	**Blegan 98B Blegan 98B**					

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
Morbidity	1	3	Bradbury 94 Bradbury 94	Bradbury 94				
Failure to Rescue	1	4	**Needleman 01** **Needleman 01**					**Needleman 01** **Needleman 01**
Patient Injuries	1	2	(Wan 87) (Wan 87)					

Table No. Outcome	No. Studies	No. Findings	No. of Findings (Clinical Grade Statistical Grade)					
			0 0	? 0	1 0	0 1	? 1	1 1
12. Perceptions of Nursing Care	6	15	**Blegen 98A (Blegen 98A)** Bostrom 93 Shukla 83 Shukla 83 Shukla 83 Hinshaw 81 Hinshaw 81	**Dobal 95**		**Sovie 00** **Sovie 00** Hinshaw 81 Hinshaw 81 Hinshaw 81	**Dobal 95**	(Shukla 83)
13. Patient Care Monitoring	2	8	Ceria 92 Ceria 92 Ceria 92 Ceria 92 Ceria 92					Carter 86 Carter 86 Carter 86
14. Nursing Documentation	4	10	Kuhn 91 Ceria 92 (Ceria 92)		(Bostrom 93)	Kuhn 91		Hinshaw 81 Kuhn 91 Kuhn 91 Kuhn 91 Kuhn 91

15. Nurse Absenteeism	2	3	**Dobal 95** **Dobal 95**				Bloom 92	
16. Nurse Satisfaction	1	2				Hinshaw 81	Hinshaw 81	
Table No. Outcome	**No. Studies**	**No. Findings**	**No. of Findings (Clinical Grade Statistical Grade)**					
			0 0	**? 0**	**1 0**	**0 1**	**? 1**	**1 1**
17. Other Aspects of Nursing	2	7	**Lanza 97** **Lanza 97** **Lanza 97** **Lanza 97** **Lanza 97** **Lanza 97** Hinshaw 81					
18. Direct Nursing Care	2	6	Shukla 83 Shukla 83			**(Arndt 98)** **Arndt 98** **Arndt 98**	**Arndt 98**	

19. Institutional Financial Outcomes	9	20	**Sovie 00** **Sovie 00** **Sovie 00** **Sovie 00** **Sovie 00** **Sovie 00** Shukla 83		Hinshaw 81 Hinshaw 81 Hinshaw 81 Bostrom 93 Behner 90 Flood 88 Glandon 89 Glandon 89 Glandon 89 Glandon 89 Halloran 83 (Osinski 80) Osinski 80			
Totals (%)	**38**	**266 (100)**	**127 (47.7)**	**4 (1.5)**	**27 (10.2)**	**33 (12.3)**	**62 (23.3)**	**62 (23.3)**

12. Aiken LH, Clarke SP, Sloane DM. Hospital restructuring: does it adversely affect care and outcomes? *JONA* **2000**;30:457-65.

13. American Nurses Association. *Nurse Staffing and Patient Outcomes in the Hospital Setting*. Washington, DC: American Nurses Publishing, **2000**

    This reference includes the data reported in: Lichtig LK, Knauf RA, Milholland DK. Some impacts of nursing on acute care hospital outcomes. *JONA* **1999**;29:25-33. This reference reports the results of the pilot study for a second ANA report: American Nurses Association. *Implementing Nursing's Report Card: A Study of RN Staffing, Length of Stay, and Patient Outcomes.* Washington, DC: American Nurses Publishing, **1997**. The findings of the second report are similar to those of the first. Only the first report was abstracted.

14. Arbesman MC, Wright C. Mechanical restraints, rehabilitation therapies, and staffing adequacy as risk factors for falls in an elderly hospitalized population. *Rehab Nursing* **1999**;24:122-128.

15. Arndt M, Crane S. Influences on nursing care volume. *J Soc Health Sys* **1998**;5:38-49.

16. BehnerKG, Fogg LF, Fournier LC, Frankenbach JT, Robertson SB. Nursing resouces management:analyzing the relationship between costs and quality in staffing decisions. *Health Care Manage Rev* **1990**;15:63-71.

17. Blegan MA, Goode CJ, Reed L. Nurse staffing and patient outcomes. *Nurs Res* **1998A**;47:43-50.

18. Blegan MA, Goode CJ, Reed L. A multisite study of nurse staffing and patient occurrences. *Nurs Econ* **1998B**;16:196-203.

19. Bloom JR, Alexander JA, Nuchols BA. The effect of the social organization of work on the voluntary turnover rate of hospital nurses in the United States. *Soc Sci Med* **1992**;34:1413-24.

20. Bond CA, Raehl CL, Pitterle ME, Franke T. Health care professional staffing, hospital characteristics, and hospital mortality rates. *Pharmacotherapy* **1999**;19:130-8.

21. Bostrom J, Zimmerman J. Restructuring Nursing for a competitive health care environment. *Nurs Econ* **1993**;11:35-41,54.

22. Bradbury RC, Golec JH, Steen PM. Relating hospital health outcomes and resource expenditures. *Inquiry* **1994**;31:56-65.

23. Carter JH, Mills AC, Homan SM, Blaesing SL, Heater BS, Stoll LD, et al. Correlating the quality of care with nursing resources and patient parameters: a longitudinal study. NLN Publication **1987**;Dec:331-45.

24. Ceria CD. Nursing absenteeism and its effects on the quality of patient care. *JONA* **1992**;22:11, 38.

25. Dobal MTE. The relationship among the context, structure, and performance of nursing units in hospitals. Unpublished doctoral dissertation, University of Texas, Austin, 1995.

26. Flood SD, Diers D. Nurse staffing patient outcome and cost. *Nurs Manage* **1988**;19:34-43.

27. Glandon GL, Colbert KW, Thomasma M. Nursing delivery models and RN mix: cost implications. *Nurs Manage* **1989**;20:30-3.

28. Grillo-Peck AM, Risner PB. The effect of partnership model on quality and length of stay. *Nurs Econ* **1995**;13:367-74.

29. Haley RW, Bregman DA. The role of understaffing and overcrowding in recurrent outbreaks of Staphylococcal infection in a neonatal special-care unit. *J Infect Dis* **1982**;145:875-85

30. Halloran EJ. RN staffing: more care—less cost. *Nurs Manage* **1983**;14:18-22.

31. Hartz AJ, Krakauer H, Kuhn EM, Young M, Jacobsen SJ, Gay G, et al. Hospital characteristics and mortality rates. *New Engl J Med* **1989**;321:1720-5.

32. Hinshaw AS, Scofield R, Atwood JR. Staff, patient, and cost outcomes of all-registered nurse staffing. *J Nurs Admin* **1981**;Nov-Dec:30-6.

33. Kovner C, Gergen PJ. Nurse staffing levels and adverse events following surgery in US hospitals. *Image J Nurs Sch* **1998**;30:315-21.

34. Krakauer H, Baily RC, Skellan KJ, Stewart JD, Hartz AJ, Kuhn EM, et al. Evaluation of the HCFA model for the analysis of mortality following hospitalization. *Health Service Res* **1992**;27:317-35.

35. Kuhn EM, Hartz A, Gottlieb MS, Rimm AA. The relationship of hospital charcteristics and the results of peer review in six large states. *Med Care* **1991**;29:1028-38.

36. Kustaborder MJ, Rigney M. Interventions for safety. *J Gerontolic Nurs* **1983**;9:159-62, 173, 182,

37. Lanza ML, Kayne HL, Gulliford D, Hicks C, Islam S. Staffing of inpatient psychiatric units and assault by patients. *J Am Psychiatr Nurses Assoc* **1997**;3:42-8.

38. Manheim LM, Feinglass J, Shortell SM, Hughes EFX. Regional variation in Medicare hospital mortality. *Inquiry* **1992**;29:55-66.

39. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelvinsky K. Nurse Staffing and patient Outcomes in Hospitals. Final Report of US DHHS Health Resources and Services Administration Contract No. 230-99-0021, Feb, **2001**.

40. Osinski EG, Powals JG. The cost of all RN staffed primary nursing. *Supervis Nurs* **1980**;January:16-21.

41. Roberson RH, Hassan M. Staffing intensity, skill mix, and mortality outcomes: the cae of chronic obstructive lung disease. *Health Serv Manage Res* **1999**;12: 258-68.

42. Shamian J, Hagen B, Hu T-W, Fogarty TE. The relationship between length of stay and required nursing care hours. *JONA* **1994**;24:52-8.

43. Shortell SM, Hughes EFX. The effects of regulation, competition, and ownership on mortality rates among hospitals inpatients. *New Engl J Med* **1988**;318:1100-7.

44. Shukla RK. All-RN model of nursing care delivery: a cost-benefit evaluation. *Inquiry* **1983**;20:173-84.

45. Silber JH, Rosenbaum PR, Schwartz JS, Ross RN, Williams SV. Evaluation of complication rate as a measure of quality of care in coronary artery bypass graft surgery. *JAMA* **1995**;274:317-23.

46. Sovie MD, Gift A, Jawad AF, Stratton L, Wallace PL, Aiken L. *Hospital Restructuring's Impact on Outcomes. Final Report.* National Institute of Nursing Research, NIH Grant No. 5 RO1 NR04285-03, **2000**.

47. Taunton RL, Kleinbeck SVM, Stafford R, Woods CQ, Bott MJ. Patient ouctomes: are the linked to registered nurse absenteeism, separation, or work load? *JONA* **1994**;24:48-55.

48. Wan TTH, Shukla RK. Contextual and organizational correlates of the quality of hospital nursing care. *QRB* **1987**;13:61-4.

.2.1 EMPIRICAL ANALYSIS OF OSHPD DATA

Richard L. Kravitz, MD, MSPH; Patrick S. Romano, MD, MPH; Michael Maher, PhD; Michael Gallagher

INTRODUCTION

In this section of the report, we describe the results of our analysis of hospital financial and discharge data obtained from the California Office of Statewide Health Planning and Development (OSHPD). We conducted these analyses in order to accomplish three general objectives. First, we wished to describe levels of nurse staffing (i.e., the distribution of nurse staffing ratios) *at the nursing unit level* in California hospitals from the most recent possible reporting period (1998-99). Knowledge of existing ratios could help DHS establish a baseline for imposing more stringent ratios and for evaluating their impact. Second, we wanted to assess the likely effects of any new regulations on nurse manpower requirements and costs across California hospitals. Different stakeholder groups have proposed widely differing ratios (Table 2), with some likely to have minimal impact on the average hospital and others likely to have major impact. Third, we wished to assess both the baseline ratios and the likely consequences of imposing varying staffing standards across different types of hospitals in different regions of the state. Some hospitals (or hospital types) might be much more vulnerable to tougher staffing standards than others, and it would be useful for policymakers to know in advance who is likely to be most affected.

DATA AND METHODS

Data Sources

Data for this analysis were obtained from the OSHPD Hospital Annual Disclosure Reports. Approximately 500 hospitals in California are required to submit this report within four months of the hospital's fiscal year end. Hospital Annual Disclosure Reports contain financial and utilization data, and are available online (http://www.oshpd.cahwnet.gov). Submitted reports are edited and audited by OSHPD. Variables collected for the report include: type of ownership and inventory of provided services; number of beds and corresponding utilization statistics by payer; balance sheet and summary income statement; revenues by payer and revenue center; expenses by natural classification and cost center; and productive hours and average hourly rates by employee classification and cost center.

Most of the analyses reported below were obtained from OSHPD's 24th Reporting Year, which covers the reporting cycle 6/30/98-6/29/99. To assess short-term stability of the findings, data were compared to OSHPD Cycle 23 (6/30/97-6/29/98). In general, all findings (including estimated nurse:patient ratios) were very similar between the two reporting cycles. In a related analysis of OSHPD data, Spetz and colleagues recently reported that nurse staffing adjusted for patient mix held steady or perhaps increased slightly between 1992 and 1998. However there was a leveling off or a slight decline in nursing personnel hours per case mix adjusted *discharge*.

Variables

.2.1.1.1.1 AB 394 Unit Types

As noted, the language of AB 394 refers to 13 different types of hospital units: critical care unit, burn unit, labor and delivery room, postanesthesia service area, emergency department, operating room, pediatric unit, step-down/intermediate care unit, specialty care unit, telemetry unit, general medical care unit, subacute care unit, and transitional inpatient care unit. On the other hand, OSHPD collects staffing and census information for a large number of "revenue centers," including 25 "daily hospital services" inpatient units and a similar number of "ancillary services" units. To create estimates of nurse staffing levels that would be relevant to AB 394 using OSHPD data, we created a crosswalk between the AB 394 and OSHPD definitions. The crosswalk is presented in the text table below and is reiterated in the results tables appearing at the end of this report.

AB 394 DESIGNATION	OSHPD COST CENTER
Burn Care	Burn Care
Critical Care	Coronary Care
Critical Care	Pediatric Intensive Care
Critical Care	Neonatal Intensive Care
Critical Care	Other Intensive Care
Critical Care	Medical/Surgical Intensive Care
Emergency	Emergency Services
General Medical Care	Medical/Surgical Acute Care
Labor and Delivery	Labor and Delivery Services
Nursery Acute	Nursery Acute
Obstetrics Acute	Obstetrics Acute
Pediatric Unit	Pediatric Acute
Psychiatric	Psychiatric Acute Adult
Psychiatric	Psychiatric Acute Adolescent & Pediatrics
Step-Down/Telemetry	Definitive Observation

Sub-Acute Care Sub-Acute Care

We estimated nursing ratios separately for psychiatric units in acute care hospitals and psychiatric units in psychiatric hospitals, because these two types of units had markedly different average staffing patterns.

.2.1.1.1.2 Metrics for Nurse Staffing

Various metrics have been used to measure levels, richness, or intensity of nurse staffing. AB 394 refers to nurse-to-patient ratios, defined as the number of nurses available to care for a single patient at any given time. Unfortunately, neither nurse-to-patient ratios nor the inverse metric (patient-to-nurse ratios) can be directly derived from administrative data.

A closely related metric, the number of nursing hours per patient day (HPD), is directly available from the OSHPD Hospital Disclosure Reports. The numerator of this metric is the total number of nursing hours worked during a given period of time, and the denominator is the total number of patients cared for multiplied by the number of 24-hour days they were under care. One problem with HPD is that total nursing hours includes time spent on vacation, leave, and other non-productive activities. Fortunately, OSHPD asks that hospitals report on productive hours (excluding vacation, leave, etc.), making it possible to calculate productive hours per patient day (PHPD). Even this measure has at least six problems, however.

First, the denominator (number of patient days) is reported by hospitals as the sum (over the number of days in a period) of the number of patients in the hospital at a given time each day (typically midnight). In other words, the average patient day is assumed to be 24 hours. For any given hospital, this may or may not be true. Assuming a standard

census time of midnight, hospitals that tend to admit patients very soon after midnight (e.g., through the emergency room) and discharge them early the next day (or the day after, or the day after that) will appear to have a lower daily census (and thus incur fewer patient days) than hospitals that admit patients late in the afternoon or evening (just before the census is taken). All else equal, such hospitals would appear to have richer nurse-to-patient ratios than is actually the case.

Second, not all "productive nursing hours" are necessarily spent at the bedside. At some hospitals, nurses may be engaged in other activities such as continuing professional education, classroom teaching, bedside instruction of student nurses, quality assurance or management activities. Thus, PHPD are likely to over-estimate the amount of actual bedside care, and the magnitude of the discrepancy may vary from hospital to hospital.

Third, the additional work required to admit and discharge patients is not captured by PHPD. Previous studies have shown that medical resource use is greatest during the first few days of hospitalization.[3] Thus, two hospitals with the same daily census – one with high patient turnover and one with low turnover – could experience very different staffing demands.

Fourth, not all patient days are alike. Patients differ in terms of severity of illness, acuity, and care requirements. The PHPD metric does not adjust for patient severity. We made a crude attempt to adjust for patient severity using DRGs. However, DRGs are designed to capture the resource demands of hospital admissions, not hospital days. For this reason, DRG-adjusted estimates can only be used for relative comparisons among different type of hospitals, not for absolute estimates of patient-to-nurse ratios. For the sake of simplicity, the estimates reported herein are not DRG-adjusted.

Fifth, not all nurses are alike. Even if nursing care hours are broken down into categories based on length and type of training (RN, LVN, aide), not all nurses are equally trained or qualified to perform specific tasks on specific nursing units. Thus, an RN assigned to the obstetrics unit may not be capable of performing at the same level of competence when floated to a cardiac telemetry unit. Similarly, hospitals that rely heavily on registry nurses may not obtain the same level of work output from an 8 or 12 hour nursing shift.

Finally, PHPD reflects average staffing across a 24 hour period and does not portray fluctuations due to day/night scheduling patterns, absenteeism, and other circumstances (both foreseen and unforeseen). In other words, the average hospital with an estimated patient-to-nurse ratio of 5:1 probably has a lower ratio about 50% of the time, and a higher ratio about 50% of the time.

Despite these difficulties, PHPD is the best available metric for estimating current nurse staffing levels in California using administrative data. PHPD can be converted to a nurse-to-patient ratio by dividing into 24 hours. To remind the

reader of the pitfalls involved in a direct conversion, we generally report staffing levels as PHPD. For the reader's convenience, we frequently provide nurse-to-patient ratios as well.

.2.1.1.1.3 Categories of Nurses

AB 394 refers specifically to licensed nurses, which includes registered nurses, licensed vocational nurses, and presumably, licensed psychiatric technicians. The OSHPD Hospital Disclosure Reports contain information on productive hours supplied by (1) registered nurses, (2) licensed vocational nurses, and (3) aides and orderlies, stratified by hospital unit. We report separately on productive hours by (1) licensed nurses (RNs plus LVNs); (2) registered nurses; (3) licensed vocational nurses; (4) aides and orderlies; and (5) all nurses combined. We report on aides and orderlies even though they are not mentioned by AB 394 because nurses and aides/orderlies can substitute for each other for certain selected tasks. Contract and registry nurses were excluded from all calculations because there was no differentiation for skill mix (RNs vs. LVNs).

.2.1.1.1.4 Categories of Hospitals

Certain kinds of hospitals are not required to provide complete financial data to OSHPD and were therefore excluded from our analysis. These include state developmental hospitals, Shriner's hospitals, Kaiser hospitals, and prison hospitals.

Among the remaining hospitals (n=406), 346 were general acute care

hospitals, 47 were psychiatric hospitals, 7 were children's hospitals, and 6 were OSHPD-defined specialty hospitals. We created categories of hospitals according to ownership status, bed size, teaching status, urban-rural location, and geographic region. Details are provided below.

Ownership status was represented by six categories: nonprofit corporation (n=163), church-related (n=43), district (n=41), University of California (n=7), for-profit (n=127), and local government (n=25).

Hospital size was represented by four categories based on the number of staffed beds: <50 (n=74), 50-99 (n=92), 100-299 (n=183), and 300 or more (n=57).

Teaching status was represented by three categories: academic medical centers (n=12), other teaching hospitals (n=24), and non-teaching hospitals (n=370). AMCs were defined as a major, geographically contiguous teaching affiliate of one of California's 8 allopathic medical schools. Other teaching hospitals were as designated by OSHPD.

Urban-rural status was represented as urban (n=66) or rural (n=340), based on the statutory definition of rural hospitals in Section 124840 of the California Health and Safety Code, which was in turn based largely on a 1982 analysis of California hospitals by OSHPD's predecessor agency.

Geographic region was represented by one of 14 Health Services Areas designated by OSHPD: Central, East Bay, Golden Empire, Inland Counties, Los Angeles County, Mid-Coast, North Bay, North San Joaquin, Northern California, Orange County, San Diego/Imperial, Santa Barbara/Ventura, Santa Clara, and West Bay.

.2.1.1.1.5 Wage Rates Used to Calculate Projected Costs

Wage rates for different categories of nurses in different cost centers (nursing units) were obtained from OSHPD (Hospital Annual Financial Report, p. 21: Detail of Direct Payroll Costs: Patient Revenue Producing Centers).

Data Management and OSPHD Data Utilization Decisions

The list below describes the data management process as well as the rules and assumptions used to create the analytic tables for this report:

1. A Microsoft SQL Server (version 7.0) was created on a Compaq Presario 5020. Log files were partitioned on the 8-Gigabyte internal system drive and the database data files were partitioned on the 60-Gigabyte external hard drive.
2. Erwin 3.2 (from Platinum Technologies – a subsidiary of Computer Associates International, Inc) was used to design a fully normalized relational database. The database was designed in accord with the data specifications set forth in the OSHPD document entitled "HOSPITAL ANNUAL DISCLOSURE REPORT CD-ROM FORMAT DOCUMENTATION" for the 23rd and 24th year of the OSHPD program (1997-1998 and 1998-99).
3. A series of handling programs was created in ActivePerl 5.6.0.623 (PERL for Windows 32 bit environments from ActiveState Corp). These programs (handlers) were used to preprocess the fixed length format ASCII data files. The handlers were each customized to reformat a unique page of the OSHPD data from the 23rd "HOSPITAL ANNUAL DISCLOSURE REPORT". According to the above OSHPD documentation guide. The programs also corrected for some minor inconsistencies in the documentation and some unusual treatments of the fixed length data on CD-ROM. These were as follows:
    a. Page 8 contained an undocumented line number 56 which was corrected for in the handler.
    b. Page 4.1(1) contained an undocumented line number 101 (representing cost center: Sub Acute Pediatrics) which was corrected for in the handler. This same line number was accounted for in the handlers for pages 9, 12, 21 and 21.1.
    c. Page 21 had ASCII data stored in an 'A' and a 'B' section. Section 'A' represented the Disclosure Report pages 21(1) – 21(5) and section 'B' represented pages 21(6)-21(10). The sections were treated separately and imported to the database independently (see #9).
4. The result sets from the PERL handlers were stored by page in ASCII comma delimited files (also referred to as CSV files in the Microsoft Excel program). They were then verified against the original ASCII fixed length format files on the OSHPD CD-ROM for accuracy and completeness.
5. The CSV files were imported into the SQL Server database using standard Microsoft *bcp.exe* (bulkcopy) routines.
6. A copy of the bulkcopy routines was kept along with the PERL files for review.
7. The imported data were verified against the original ASCII fixed length format files on the OSHPD CD-ROM for accuracy and completeness.
8. All hospital and cost center data were imported for integrity, checksums, and accurate cross-checking. No data items were excluded. OSHPD totals were also imported for verification and due diligence.
9. The Microsoft SQL Server console for the Microsoft Enterprise Manager was used to create a series of interdependent data Views. These Views are virtual tables of data, which are reformatted and restricted to display only the specified data for analysis (see attached diagram). This ensures that the complete data set remains on the system for integrity of the data set.
10. A View of selected start dates was created using the following rationale. Hospitals that submitted more than one report for a given OSHPD period were submitted to an algorithm to determine the most useful date of submission. Only that submission was used for analysis. There were no facilities that submitted more

than two reports. The algorithm to determine the appropriate period considered the following:

a. If the length of the first period and the length of the second period (in days) were similar, the more recent period was used. The length of the periods were considered similar if the ratio of the shorter period to the longer period was greater than or equal to 0.9.
b. If the ratio was less than 0.9, the longer period was used.

11. OSPHD pages 21A and 21B (see above #3) contained similar but different data formats that were concatenated in a union view and treated as a full set. 21A was stored in units of patient days (by census) and 21B was stored in various units (Visits for Emergency Department, Births for Labor and Delivery).

.2.2.1 *Analytic Approach*

For each collection of OSHPD cost centers corresponding to an AB 394-designated hospital unit, we calculated the mean, standard deviation, and percentiles of the distribution of productive hours per patient day (PHPD). The analysis was repeated for: (1) all licensed nurses; (2) RNs only; (3) LVNs only; (4) aides and orderlies only; and (5) all nurses and support personnel combined (categories 1-4, above). PHPD were calculated for each hospital unit within each hospital as the sum of productive hours for that unit in the period of interest divided by the sum of the daily census in that unit during that period. For each unit, we also estimated the average number of patients per nurse (nurse-to-patient ratio) by dividing PHPD into 24 (i.e., average patients per nurse = 24/PHPD).

Two exceptions to this general algorithm involved labor and delivery (L&D) units and emergency departments (EDs). For L&D units, we calculated productive hours per delivery, because no other measure of patient care activity was available for these units. For EDs, we calculated productive hours per patient discharge (ED visit), because no other measure of patient care activity

was available for these units. However, we ultimately decided not to report these estimates because the mean length of stay in the ED is likely to vary widely across hospitals. For example, the patient-to-nurse ratio in an ED that sees 24 patients per day with 3 nurses (one per 8-hour shift) could be as low as 1:1 if each patient stays one hour or as high as 8:1 if each patient stays 8 hours. In the absence of any information about the mean length of stay of ED patients, productive hours per ED discharge was judged not to be a useful metric. No statistics were calculated for nursery units because these units lacked any census data.

Outliers were assessed and treated as depicted in the text table below. The general principle was to exclude hospitals from specific analyses when the data reported seemed so extreme as to almost surely represent a mistake in data collection or reporting. For example, in general medical care units (categorized under "all other units" in the table), we excluded hospitals that reported fewer than 0.5 or greater than 24 productive RN hours per patient day. Thus, if a general medical care unit reported average registered nurse-to-patient ratios leaner than 1:48 or richer than 1:1, they were excluded from subsequent analyses.

Staff Type	AB 394 Unit	Nurse Hours per Patient Day calculation must meet the following criteria :
RN (Registered Nurses)	Critical Care	4-24
	Labor and Delivery	2-48 (per delivery)
	All Other Units	.5-24
LVN (Licensed Vocational Nurses)	Critical Care	0-24
	Labor and Delivery	0-48 (per delivery)
	All Other Units	0-12
Aides and Orderlies	Critical Care	0-12

Staff Type	AB 394 Unit	Nurse Hours per Patient Day calculation must meet the following criteria :
	Labor and Delivery	0-48 (per delivery)
	All Other Units	0-12
Licensed Nurses (RN + LVN)	Critical Care	4-24
	Labor and Delivery	4-48 (per delivery)
	All Other Units	1-24
All Nursing Staff (RN + LVN + Aides and Orderlies)	Critical Care	4-48
	Labor and Delivery	4-48 (per delivery)
	All Other Units	1-24

In this report, we consider the entire population of California hospitals reporting financial data to OSHPD. We do not make inferences to any larger population. Therefore, we do not report the results of any inferential statistical tests in this report.

RESULTS

.2.3.1 *Analysis Across All California Hospitals*

Tables 3-6 give estimates of productive nursing care hours per patient day (and corresponding mean patient-to-nurse ratios) for all California acute care and psychiatric hospitals reporting complete financial data to OSHPD for the 1998-99 reporting period (i.e., Kaiser, Shriner's, State and Federal hospitals, long term care facilities, and alternative birthing centers are excluded).

In Table 3, we report data for licensed nursing staff (RNs plus LVNs). Mean productive RN/LVN staffing ranged from a mean of 14.8 hours per patient day in critical care units to 3.6 hours in psychiatric units within psychiatric hospitals. Several specific results are worth noting. First, licensed nursing staff levels in critical care units are about what might be expected (1 nurse to approximately 1.63 patients) and are in accordance with Title 22 of the California Code of Regulations (which mandates a minimum ratio of 1:2 in critical care units). Second, other units in which one would *expect* to find richer staffing (e.g., step down/telemetry, pediatrics, labor and delivery) tended to *have* richer staffing. This speaks indirectly to the validity of the data and analysis. Third, the median estimated ratio for general medical care units was about 1 nurse to 5 patients with an

interquartile range extending from 1:5.6 to 1:4.1. That is, most general medical care (medicine/surgery) units have average licensed nurse staffing ratios falling somewhere between 1:4 and 1:6. However, examination of the 5th and 95th percentiles reveals that up to 5 percent of hospitals may have med/surg staffing ratios as rich as 1:2.67 (i.e. better than 1 nurse to 3 patients, on average) while another 5 percent of hospitals may have ratios as lean as 1:7.6 (i.e. worse than 1 nurse to 7 patients). Thus, California hospitals appear to exhibit considerable variation in their average licensed nurse staffing levels.

Tables 4 through 7 provide data on registered nurses (Table 4), licensed vocational nurses (LVNs) (Table 5), aides and orderlies (Table 6), and all nurses combined (Table 7). There is about 1 registered nurse per 3 patients on pediatrics, per 4 patients in step down/telemetry units, and per 5 patients on general medical care (med/surg) units (Table 4).

On average, most hospital units employed about 1 productive hour of LVN time per patient day (Table 5). The exception is subacute care units, which employ about 2.4 hours of LVN time per patient day. There is more variation across hospitals in the use of LVNs than in the use of RNs. This can be seen by comparing the coefficients of variation (CV, defined as the standard deviation divided by the mean) in Table 5 compared to Table 4. CVs for registered nurses are on the order of ¼ to ½, whereas for licensed vocational nurses they are in the range of 1 to 2.

Aides and orderlies typically outnumber LVNs in most units (Table 6). They are employed to a greater extent in subacute care units (mean PHPD, 3.51) and psychiatric units (mean PHPD, 2.3 for psych units in acute care hospitals and 3.0 in psychiatric hospitals) than in general medical care units (2.2) or pediatric units (1.5) (Table 6).

Table 7 is at the same time both reassuring and cautionary. On the one hand, keeping certain caveats in mind, the average patient in a California hospital receives something short of 5.7 hours (psychiatric units in acute care hospitals) to 15.0 hours (critical care units) of nursing care per 24 hour hospital stay.[2] Med/surg patients receive an average of 7.4 hours of care, which is roughly equivalent to 1 caregiver per 3.24 patients. The important caveats are that these are average figures, that the calculated nursing hours do not necessarily represent bedside care, and that the skill mix of the providers rendering the care may vary substantially (from an all RN workforce at some

[2] The reason patients receive "something short of" 5.7-15.0 hours of care is that PHPD do not necessarily reflect time at the bedside.

hospitals to a team model employing many aides supervised by a single RN at other hospitals).

.2.3.1.1.1 ***Skill Mix***

Figures 1 through 5 depict the proportion of productive hours supplied by RNs, LVNs, and aides/orderlies in eight different types of nursing units. As expected, critical care units have the richest skill mix (92% RNs), followed by labor and delivery units (91%), pediatric units (76%), step down/telemetry units (66%), general medical care units (60%), and psychiatric units within acute care hospitals (Figures 1-4). Psychiatric units within psychiatric hospitals and subacute care units are staffed primarily (>50%) with LVNs, aides and orderlies (Figures 4-5).

.2.3.1.1.2 Stratified Analysis

Tables 8-12 focus on mean productive licensed nursing hours (RNs and LVNs only), looking across different categories of hospitals. We emphasize licensed nursing hours since AB 394 pertains to licensed nurses. Mean PHPD and their standard deviations are given for each hospital stratum.

Table 8 examines the relationship between licensed nurse PHPD and hospital bed size. For most hospital units, staffing is richer within smaller hospitals (<50 beds). For example, in general medical care (med/surg) units, mean unadjusted hours per 24-hour patient day was 5.0 in large hospitals and 7.6 in small hospitals. This finding is consistent with the observation that small hospitals must maintain a certain minimum cadre of nurses on the floor at all times regardless of patient census, both to provide for current needs (even if there is only 1 patient on the floor, that patient still needs a nurse) and acute fluctuations (emergency admissions). However, there were some notable exceptions to this general trend: compared to larger hospitals, small hospitals had leaner ratios in pediatrics and equivalent ratios (expressed as productive nursing hours per delivery) in labor and delivery units (Table 8). In the case of pediatrics, small hospitals are likely to have less severe casemix (because sicker patients are transferred to specialty or teaching hospitals), and seem less likely to have dedicated ("24/7") pediatrics units with separate staffing. In the case of obstetrics, the consistency of staffing levels across hospital strata is remarkable (about 18 productive nursing hours per delivery at all hospital types). In addition, there is relatively little variation within strata (coefficients of variation, ~8/18=0.44).

Table 9 examines nurse staffing ratios among hospitals by teaching status. Academic medical centers tend to have richer staffing ratios than either other teaching

hospitals or non-teaching hospitals. This may be related to the more complex mix of patients associated with academic centers. Surprisingly, teaching hospitals other than AMCs had leaner nurse staffing ratios than non-teaching hospitals (at least on general medical care, pediatrics, acute obstetrics, and psychiatric units). One possible explanation is that "other teaching" hospitals use physician trainees to perform some of the work (e.g., intravenous line starts, blood cultures) otherwise assigned to nurses.

The pattern of results in Table 10 (urban vs. rural hospitals) is very similar to that observed in Table 8 (hospital bed size). Like small hospitals, rural hospitals tend to have richer med/surg ratios and leaner pediatric ratios.

Table 11 indicates that for-profit hospitals generally have leaner ratios than non-profit hospitals, especially on medical-surgical and psychiatric units.

Table 12 and Figure 6 show considerable geographic variation. Focusing on the medical-surgical unit results, the leanest staffing levels are found in Los Angeles, Orange, and Santa Clara Health Services Areas, while the richest are found in rural Northern California and the West (SF) Bay.

.2.3.1.1.3 Projected AB 394 Effects

Proportion of hospitals in deficit

As noted earlier, the Department of Health Services is considering staffing proposals from several stakeholder organizations (Table 2). We calculated the percentage of hospitals that would be in "substantial deficit" relative to these proposals for general medical care units, definitive observation (step down/telemetry) units, pediatric units, psychiatry units in acute care hospitals, psychiatry units in psychiatric hospitals, and subacute care units. A nursing unit (OSHPD cost center) was considered to be in substantial deficit if the number of productive hours of licensed nursing care per patient day was more than 5% lower than the standard created by a specific organizational proposal (Table 13). For example, in the original version of AB 394, a 1:6 ratio was suggested for general medical care ("med/surg") units. Taking into consideration all the caveats presented earlier, a 1:6 ratio is roughly equivalent to 4.0 productive hours per patient day. Thus, if a unit reported fewer than .95*4.0=3.8 PHPD, it was considered in deficit with respect to the standards of the original version of AB 394. Sixteen percent of general medical care cost centers in California were in deficit when judged by this standard (Table 3).

The results displayed in Table 13 can be summarized as follows. First, under the arguably lean ratios proposed by the California Hospital Association (CHA), relatively few hospitals (0 to 5 percent) would be considered in substantial deficit. Second, under the correspondingly rich ratio standards proposed by the California Nurses

Association, many if not most hospitals (48 to 93 percent) would be in deficit. Third, if DHS imposed standards based on the actual standards now in use by the University of California, about 1 in 6 California hospitals would fall below the standard for med/surg (general medical care), about 1 in 12 for pediatrics, and 1 in 20 for step down/telemetry (definitive observation) (Table 13).

.2.4.1 Number of deficit hours and deficit FTE

.2.5.1 We next estimated the number of additional productive nursing hours required to make up the deficits associated with each of the AB 394-related staffing proposals. For each cost center (unit type) within each hospital, we compared that cost center's actual number of productive licensed nursing hours per patient day with the number that would be required to meet the standard proposed by a particular stakeholder organization. For example, if a hospital reported 1000 patient days and 4000 productive licensed nursing hours in its general medical care cost center, that would correspond to a nurse:patient ratio of 1:6. Thus, that hospital would have no deficit relative to the original AB 394 proposal (1:6) but would be in significant deficit with respect to the revised CNA proposal (1:3). In fact, the hospital would be exactly 4000 hours in deficit (a ratio of 1:3 corresponds to 8 PHPD or 8000 hours in our hypothetical hospital; 8000-4000=4000). This analysis assumes no fungibility – that is, a surplus in one patient care area cannot be used to make up a deficit in another.

.2.6.1 The results show that the number of productive hours needed to make up the estimated deficits varies enormously across proposals and units (Table 14). For example, general medical care units would need to purchase an additional 9.49 million productive licensed nursing hours to come into compliance, *on average*, with the standards promulgated in the revised CNA proposal (Table 14). On the other hand, under the CHA proposal certain units (step down/telemetry units, acute psychiatric units, and subacute care units) would experience no deficit at all. As before, this analysis assumes no fungibility; i.e., surplus hours in one patient care area cannot be used to make up for deficits in another. While this assumption is fundamentally conservative, we believe it is sound because hospitals are unlikely to be significantly overstaffed relative to acuity (except perhaps in small or rural hospitals, where some units must be staffed

even if there are no patients).

By dividing the estimated deficits (in hours) by the number of productive hours in a year (.85*2000=1700 hours), we generated estimates of the number of licensed nurse FTE required to come into compliance with the various proposals. The results (Table 15) show that non-Kaiser hospitals in California would have to hire between 74 and 5586 medical/surgical (general medical care) nurses, between 0 and 782 step down/telemetry nurses, and between 3 and 150 pediatric nurses to meet the standards of the various proposals – at least on average (Table 15). We continue to assume no fungibility (an assumption that might lead to over-estimation of the number of nursing hours hospitals would need to purchase) but we also assume that nurses can be hired in fractional units. In fact, many of the estimated deficits amount to less than one nurse FTE on a hospital unit. This assumption may not always be valid – in some markets, nursing registries may not be available and/or nurses may only be willing to work in full-time positions. We also assume that hospitals will increase their *average* staffing up to the average level required by DHS, despite the fact that AB 394 actually stipulates *minimum* staffing levels. A hospital that maintains average staffing at the required level will find itself above the mandated patient-to-nurse ratio for a substantial portion of every day, week, or month. We have no way to estimate the additional number of FTEs that would be necessary to maintain staffing above the proposed required levels 24 hours per day, 365 days per year.

.2.7.1 Projected costs of remediation

.2.8.1 We estimated the costs hospitals might incur in correcting nursing deficits under various standards by multiplying, for each unit (i.e., general medical care, pediatrics, etc.) within each hospital, that unit's deficit of productive licensed nursing hours times the "average unit-specific prevailing wage" (AUPW). This is the average of the wages paid to RNs and LVNs on that unit, weighted by the proportion of productive hours contributed by each type of nurse. An example is shown in the box below. This calculation involved making the following assumptions:

- We assume that hospitals will make up any deficit of licensed nursing hours by maintaining the same skill mix (i.e., ratio of RNs to LVNs) that they currently use. This assumption may be in error because hospitals will have strong incentives to use less costly personnel (LVNs).

- We assume that the cost of marginal nursing hours is the same as the cost of average nursing hours, for each unit within each hospital. This assumption violates microeconomic principles. Even if hospitals use less skilled personnel to provide marginal nursing hours, they will probably need to spend more to attract these personnel into their communities, or into the labor force at all. They may also need to rely more heavily on registry personnel, who typically cost more than staff nurses because of their relative inefficiency and agency-associated overhead costs.

- We assume that AB 394 will have no effect on nursing wages in California. If, in fact, there is a nursing shortage in California, then prevailing wages are likely to increase as hospitals compete for a limited pool of available nurses.
- We ignore all costs associated with recruiting, hiring, training, supervising, and managing these additional nurses.
- Because of data limitations, we ignore any deficits in emergency departments, labor and delivery units, or specialty units within acute care hospitals.

EXAMPLE of PROJECTED COST CALCUATIONS
"Golden State Hospital"
Number of patient days in general medical care units 1998-99: 1000
Number of licensed nursing hours 1998-99: 4000
Average nurse-to-patient ratio: 1:6
Number hours required to meet CNA standard (1:3): 8000
Number of hours in deficit: 4000
Average hourly wages and benefits of RNs working on med/surg units at this hospital: $45
Average wages and benefits of LVNs working on med/surg units at this hospital: $25
Number of RN hours 1998-99: 3000
Number of LVN hours 1998-99: 1000
Weighted average wage (AUPW): 3000*45 + 1000*25 / 4000 = $40
Projected cost to make up deficit: 4000*$40= $160,000

Unadjusted projected costs of redressing deficits of licensed nursing hours range from $0 (Step Down/Telemetry, Psychiatric Hospital, and Subacute Care units under the CHA proposal) to $488,600,000 (General Medical Care units under the CNA proposal) (Table 16a). These costs were calculated under the assumption of complete non-fungibility, which may not be valid if hospitals can manage to move nursing budgetary dollars from units that are staffed more richly than the regulations require to units that are under-staffed. In addition, we provide 2000-2001 wage-adjusted projected costs, based on the assumption that hospitals would have to hire staff in full time equivalents and that compensation for these additional FTEs would vary according to the skill mix reported for each unit (Table 16b). We adjusted these numbers down a bit,

following the work of Lichtig [1] and Needleman [2], assuming that each additional hour of nurse staffing per patient day would shorten mean length of stay by an estimated 5.1% for acute care patients. This percentage is the mean of the reduced length of stay reported in Lichtig for California in 1992 (4.8%) and 1994 (5.4%), and corresponds to the mean of the reduced length of stay for medical (9%) and surgical units (1%) reported in Needleman. We found no evidence of such an effect for psychiatric or subacute patients, and therefore did not adjust projected costs in those categories.

To assess the impact of our assumptions, we performed a sensitivity analysis that allowed hospitals to move nursing dollars (and presumably nurses) from: 1) critical care units to general medical care units; 2) critical care units to telemetry units; 3) telemetry units to general medical care units; and 4) general medical care units to telemetry units. In general, the results showed that hospitals could save up to a third of projected costs by performing such switches (data not shown in main table series; see Appendix 2 for details).

The projected financial impact on hospitals that are redressing deficits is likely to be understated by our calculations. Hiring additional nurses imposes transaction costs on hospitals that must advertise, review applications, interview applicants and otherwise incur costs of adding nurses to existing staff. In addition to these transaction costs, hospitals will likely incur additional indirect nursing costs, such as supervision, employee record maintenance, payroll processing, and human resources management. These transaction costs and indirect costs might add substantially to our calculations of additional nursing costs.

Our analysis assumes that hospitals will be equally efficient in using nursing resources after redressing nursing deficits as they were in the

reporting period that is the basis for our data collection. It is possible, perhaps even likely, that hospitals will be less efficient after hiring additional nurses. The notion of constrained optimization from economics predicts that the imposition of a new constraint on a system (e.g., AB 394) will not lead to a more efficient allocation of resources than before the constraint was imposed, and possibly the constraint will lead to a less efficient allocation of resources. If the new constraints lead to a less efficient allocation of nursing resources to patient care, then our calculations of the increased cost of redressing nursing deficits will understate the actual increased cost.

SUMMARY AND CONCLUSIONS

In summary, we conducted an analysis of Hospital Financial Disclosure data supplied by the California Office of Statewide Health Planning and Development. The results support the following conclusions:

1. The data indicate that *average* nurse staffing in California is roughly what might be expected: between 1:1 and 1:2 in critical care units; somewhat leaner than 1:4 in general medical care units and a bit richer in telemetry units; better than 1:3 in pediatric units; and worse than 1:5 in subacute care units and psychiatric units within specialized psychiatric hospitals.

2. There is considerable variation among hospitals in terms of staffing. The inter-quartile range (difference between hospitals in the 25th percentile and those in the 75th percentile) for general medical care units is 4.3 to 5.9 PHPD, which translates roughly into ratios of 1:4 to almost 1:6.

3. A good deal of care must be taken in interpreting these figures. Productive nursing hours do not translate readily into nurse-to-patient ratios.

4. Nurse staffing levels in California vary by hospital bed size, teaching status, urban-rural status, hospital ownership, and geography. Smaller and rural hospitals must staff at higher levels to meet contingencies. Academic Medical Centers have richer staffing, perhaps to deal with more complex patients. For-profit hospitals staff more frugally than non-profit hospitals. Hospitals in Los

Angeles, Orange, and Santa Clara counties appear to have leaner staffing ratios than other geographic areas in the state.

5. The staffing proposals submitted by AB 394 stakeholders vary widely and have tremendously different implications for the proportion of hospitals in deficit, the number of nursing FTEs required to make up the deficits, and the costs of redressing the deficits. At one extreme, the proposal by the California Nurses Association to staff general medical units at 1:3 would place 92% of non-Kaiser hospitals in deficit and require 5586 licensed nurses, costing $279.9 million to redress deficiencies. At the other extreme, the 1:10 proposal by the California Hospital Association would place only 4% of hospitals in deficit and require a mere 74 nurses ($3.7 million) to make it up.

6. These projections depend on a variety of assumptions that are subject to debate. The most important assumptions are that productive hours can be translated into nurse-to-patient ratios, that average staffing levels approximate minimum staffing levels, that "fractional nurses" are available for purchase at current (average) wage rates, and that nurses are non-fungible across units because no units are currently "over-staffed."

7. These findings have considerable implications for the implementation of AB 394 regulations.

.2.8.1.1

1. Lichtig LK, Knauf RA, Milholland DK. Some impacts of nursing on acute care hospital outcomes. *JONA* **1999**;29:25-33.

2. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelvinsky K. Nurse Staffing and patient Outcomes in Hospitals. Final Report of US DHHS Health Resources and Services Administration Contract No. 230-99-0021, Feb, **2001**.

3. Taheri PA, Butz DA, Greenfield LJ. Length of stay has minimal impact on the cost of hospital admission. J Am Coll Surg. Aug **2000**;191(2):123-30.

.2.9.1 Table 1. Excerpts from AB 394.

"This bill would require the department, with regard to general acute care hospitals, acute psychiatric hospitals, and special hospitals, to adopt regulations that establish certain minimum nurse-to-patient ratios, and would require these health facilities to adopt written policies and procedures for training and orientation of nursing staff."

"….the State Department of Health Services shall adopt regulations that establish minimum, specific, and numerical licensed nurse-to-patient ratios by licensed nurse classification and by hospital unit for all health facilities licensed pursuant to subdivision (a), (b), or (f) of Section 1250…..The department shall review these regulations five years after adoption and shall report to the Legislature regarding any proposed changes….As used in this subdivision, "hospital unit" means a critical care unit, burn unit, labor and delivery room, postanesthesia service area, emergency department, operating room, pediatric unit, step-down/intermediate care unit, specialty care unit, telemetry unit, general medical care unit, subacute care unit, and transitional inpatient care unit.

"These ratios shall constitute the minimum number of registered and licensed nurses that shall be allocated. Additional staff shall be assigned in accordance with a documented patient classification system….

"The regulations adopted by the department shall augment and not replace existing nurse-to-patient ratios that exist in regulation or law for intensive care units, the neonatal intensive care units, or the operating room….nor existing licensed staff-to-patient ratios for hospitals operated by the State Department of Mental Health."

.2.10.1 Table 2. Proposed AB 394 nurse staffing levels.

Unit Type	Original AB394	C.N.A.*	SEIU	*.2.10.1.1*	UC Hospitals	C.H.A.	CDHS**
Critical Care, Burn, and Neonatal ICU	1:2	1:2	1:2	1:2	1:2	1:2	---
Labor & Delivery	1:2	1:2	1:2	1:2	1:3	1:3	1:2 L&D only 1:6 Postpartum only 1:3 Comb. L&D/Postpartum
Post Anesthesia	1:2	1:2	1:2 adult, 1:1 peds	1:2	1:3	1:3	1:2
Emergency Department	1:2		1:3	1:3	1:3	1:3	1:4 1:3 1:2
Operating Room	1:1	1:1	1RN + 1 LVN/tech	1:1	1:1	1:1	---
Pediatric Unit	1:3	1:3	1:3	1:3	1:5	1:6	1:3
Step Down/ Intermediate Care	1:3	1:3	1:3	1:3	1:4	1:6	1:4 Stepdown Only 1:4 Comb. Stepdown/Telemetry
Specialty Care Unit	1:4	1:3	-	1:3	-	-	see Oncology
Telemetry Unit	1:4	1:3	1:3	1:3	1:6 days, 1:7 nights	1:10	1:5 Telemetry Only
Oncology Unit	1:4	-	-	1:4	1:6 days, 1:7 nights	1:10	Oncology: 1:3
General Medical Unit	1:6	1:3	1:4	1:4	1:6 days, 1:7 nights	1:10	1:6, 1:5 Medical Only 1:6, 1:5 Surgical Only 1:6, 1:5 Comb. Medical/Surgical

Subacute/ Transitional Care	1:6	1:4	1:5	1:5	-	1:12	---***
Psychiatric Unit	-	1:4	1:3	1:5	Age specific	1:12	1:6

* Issued March 12, 2001. To be counted in ratios, LVN's must be supervised by a resource RN in a ratio of 1 RN:3 LVNs on wards and 1:1 in ICUs.
**Updated, January 2002
***Commencing January 1, 2002, the nurse to patient ratio in a Subacute unit and a Transitional program in a general acute care hospital shall, at a minimum, meet the staffing requirements contained in the Subacute and Transitional inpatient care contracts between the Medi-Cal program and the general acute care hospital

.2.11.1 Table 3. **Productive** licensed nursing hours **(RN + LVN hours) per patient day*, by AB 394 designated nursing unit type, 1998-99.**

AB 394 Unit Type	Number of Hospitals (N)	Number of Units (N)	Productive Licensed Nursing Hours Per Patient Day*							Estimated Number of Patients Per Licensed Nurse (Mean)*
			Mean	SD	5%ile	25%ile	Median	75%ile	95%ile	
Critical Care	299	548	14.76	2.97	10.41	12.99	14.32	16.34	20.61	1.63
General Medical Care	334	334	5.53	2.6	3.14	4.3	5.1	5.9	8.98	4.34
Step-down / Telemetry	129	129	6.67	2.05	4.08	5.31	6.16	7.69	10.35	3.60
Pediatric	149	149	8.52	3.21	4.01	6.29	8.11	10.13	14.62	2.82
Labor & Delivery	227	227	18.57	7.08	8.35	13.86	17.67	21.83	32.63	1.29
OB Acute	236	263	6.94	3.74	2.61	4.83	5.87	8.34	14.98	3.46
Sub-acute Care	38	38	4.60	1.64	2.45	4.03	4.3	4.75	6.81	5.22
Psychiatric: Acute Care Hospitals	115	125	5.07	2.07	2.49	3.87	4.64	5.91	9.92	4.73
Psychiatric: Psychiatric Hospitals	46	82	3.55	1.21	2.1	2.56	3.29	4.4	5.6	6.76

.2.12.1

.2.13.1

.2.14.1 ***For Labor & Delivery, read as "Productive Licensed Nursing Hours Per Delivery"**

Table 4. **Productive** registered nursing hours **(RN hours) per patient day*, by AB 394 designated nursing unit type,**

.2.15.1 1998-99.

AB 394 Unit Type	**Number of Hospitals (N)**	**Number of Units (N)**	*.2.15.1.1 Productive Registered Nursing Hours Per Patient Day**							**Estimated Number of Patients Per Registered Nurse (Mean)***
			Mean	SD	5%ile	25%ile	Median	75%ile	95%ile	
Critical Care	310	561	14.42	3.19	9.47	12.49	14.12	16.01	20.2	1.66
General Medical Care	336	336	4.53	2.2	2.23	3.41	4.19	5.11	7.87	5.30
Step-down/ Telemetry	128	128	5.85	1.99	3.33	4.54	5.36	6.79	9.82	4.10
Pediatric	151	151	7.8	3.3	3.21	5.24	7.38	9.63	14.29	3.08
Labor & Delivery	227	227	18	6.92	7.76	13.41	17.35	21.01	30.73	1.33
OB Acute	235	235	6.25	3.88	2.06	3.96	5.15	7.26	14.64	3.84
Sub-acute Care	38	38	2.19	1.41	0.77	1.3	1.63	2.76	5.72	10.96
Psychiatric: Acute Care Hospitals	115	125	3.88	1.56	1.87	2.85	3.69	4.54	7.02	6.19
Psychiatric: Psychiatric Hospitals	47	83	2.48	0.99	1.28	1.83	2.37	3.04	4.23	9.68

*For Labor & Delivery, read as “Productive Registered Nursing Hours Per Delivery”

Table 5. Productive **LVN hours** per patient day*, by AB 394 designated nursing unit type, 1998-99.

AB 394 Unit Type	**Number of Hospitals (N)**	**Number of Units (N)**	*.2.15.2.1 Productive LVN Hours Per Patient Day**				
			Mean	SD	25%ile	Median	75%ile
Critical Care	257	484	0.97	1.82	0.04	0.32	0.99
General Medical Care	332	332	1.03	1.23	0.3	0.72	1.35
Step-down/ Telemetry	121	121	0.85	0.87	0.08	0.6	1.37
Pediatric	131	131	0.82	1.01	0.11	0.42	1.13
Labor & Delivery	140	140	1.01	1.77	0.04	0.3	1.31
OB Acute	207	207	0.93	0.97	0.25	0.62	1.31
Sub-acute Care	38	38	2.42	1.39	1.68	2.62	3.06
Psychiatric: Acute Care Hospitals	109	119	1.25	1.21	0.5	1.04	1.65
Psychiatric: Psychiatric Hospitals	45	79	1.06	0.66	0.51	0.93	1.42

*For Labor & Delivery, read as "Productive LVN Hours Per Delivery"

Table 6. Productive **aide and orderly hours** per patient day*, by AB 394 designated nursing unit type, 1998-99.

AB 394 Unit Type	Number of Hospitals (N)	Number of Units (N)	Productive Aide/Orderly Hours Per Patient Day*				
			Mean	SD	25%ile	Median	75%ile
Critical Care	273	513	0.63	1.12	0.03	0.13	0.85
General Medical Care	333	333	2.23	1.52	1.23	2.19	2.93
Step-down/ Telemetry	130	130	1.99	1.59	0.64	1.83	2.93
Pediatric	135	135	1.47	1.55	0.24	1.14	2.18
Labor & Delivery	152	152	1.33	1.71	0.08	0.68	2.17
OB Acute	210	210	0.96	1.07	0.14	0.62	1.4
Sub-acute Care	37	37	3.51	1.22	2.95	3.5	4.16
Psychiatric: Acute Care Hospitals	108	118	2.26	1.85	0.74	1.97	3.33
Psychiatric: Psychiatric Hospitals	36	61	3	1.48	1.89	2.97	3.6

*For Labor & Delivery, read as "Productive Aide and Orderly Hours Per Delivery"

Table 7. Productive **total nursing care hours** per patient day* (RN, LVN, Aides & Orderlies), by AB 394 designated nursing unit type, 1998-99.

AB 394 Unit Type	Number of Hospitals (N)	Number of Units (N)	Productive Total Nursing Hours Per Patient Day*				
			Mean	SD	25%ile	Median	75%ile
Critical Care	295	541	15.18	3.09	13.27	14.72	16.85
General Medical Care	331	331	7.44	2.41	6.27	7.29	8.36
Step-down/ Telemetry	129	129	8.59	2.45	7.01	8.17	9.46
Pediatric	148	148	9.74	3.2	7.8	9.36	11.53
Labor & Delivery	227	227	19.43	7.33	15.34	18.26	22.66
OB Acute	236	236	7.79	3.81	5.47	6.8	9.31
Sub-acute Care	38	38	8.02	2.46	6.84	7.55	8.57
Psychiatric: Acute Care Hospitals	48	84	5.69	2.21	4.23	5.6	6.72
Psychiatric: Psychiatric Hospitals	115	125	7.19	2.91	5.16	6.38	8.61

*For Labor & Delivery, read as “Productive Nursing Care Hours Per Delivery”

Figure 1.

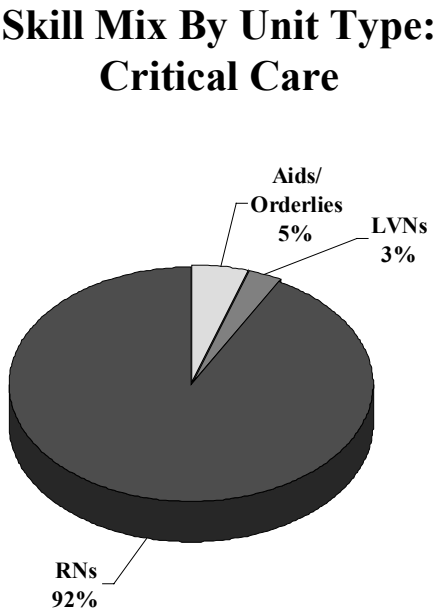

Skill Mix By Unit Type:
Critical Care
Aids/
Orderlies
5%
LVNs
3%
RNs
92%

Figure 2.

Skill Mix By Unit Type: Labor & Delivery and Pediatric

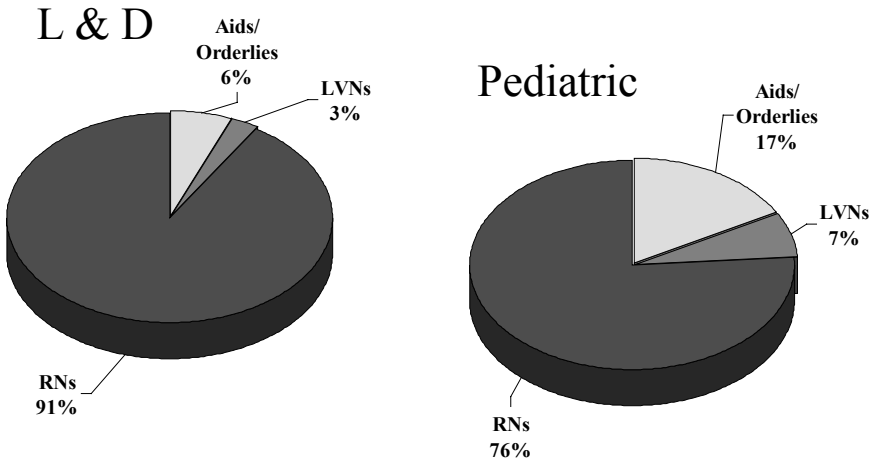


Figure 3.

Skill Mix By Unit Type: OB Acute

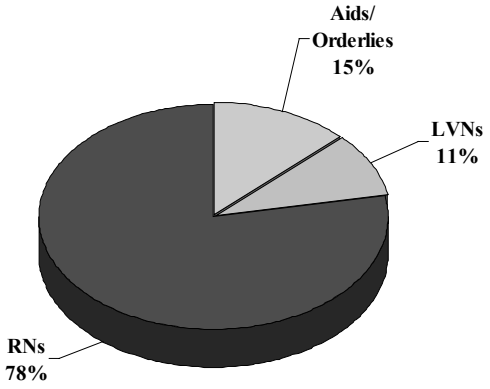


Figure 4.

Skill Mix By Unit Type: Gen Med Care and Step-down/Tele

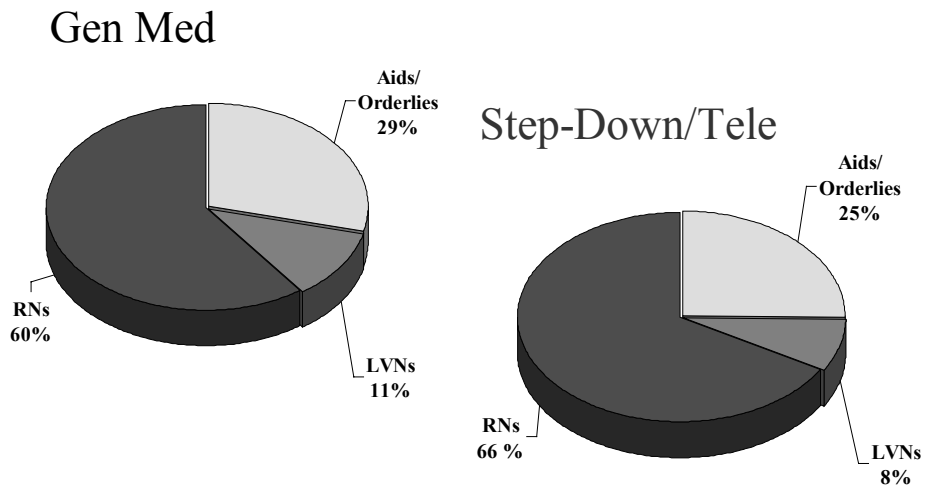


Figure 5.

Skill Mix By Unit Type: Sub-Acute Care

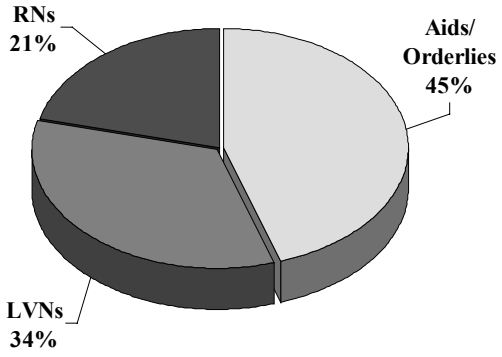


Table 8. ***Productive*** *licensed nursing hours* ***per patient day,*** *by hospital size.*

AB 394 Unit Type	Mean Productive Licensed Nursing Hours (SD)			
	Hospital Size (Licensed Beds)			
	Small (<56 beds) (n=74)	**Small-Medium (56 – 99 beds) (n=92)**	**Medium-Large (100 – 299 beds) (n=183)**	**Large (>=300 beds) (n=57)**
Critical Care	16.04 (3.92)	15.55 (2.62)	14.48 (2.90)	14.27 (2.75)
General Medical Care	7.62 (4.83)	5.61 (1.7)	4.95 (1.63)	5.10 (1.21)
Step-down/ Telemetry	9.95 (1.88)	7.36 (2.71)	6.51 (1.92)	6.58 (1.92)
Pediatric	3.43 (2.34)	7.99 (4.19)	8.69 (3.11)	8.8 (2.87)
Labor & Delivery	18.31 (7.69)	18.85 (7.24)	18.61 (7.71)	18.36 (4.63)
OB Acute	9.62 (4.98)	8.09 (4.55)	6.45 (3.23)	5.91 (2.74)
Sub-acute Care	4.92 (1.32)	4.4 (0.31)	4.95 (2.06)	3.80 (1.03)
Psychiatric: Acute Care Hospitals	5.27 (1.38)	6.42 (3.51)	5.07 (2.10)	4.56 (1.16)
Psychiatric: Psychiatric Hospitals	3.28 (1.51)	3.51 (1.04)	4.08 (2.68)	N/A

*Table 9. **Productive** licensed nursing hours, by hospital teaching status.*

.2.15.2.1 AB 394 Unit Type	**Mean Productive Hours (SD)**		
	.2.15.3.1 Teaching Status		
	Academic Medical Center (n=12)	**Other Teaching Hospital (n=24)**	**Non-teaching Hospital (n=370)**
Critical Care	16.58 (1.86)	15.17 (2.65)	14.66 (3.01)
General Medical Care	6.38 (1.18)	4.88 (1.26)	5.56 (2.69)
Step-down/ Telemetry	9.19 (1.59)	7.67 (1.84)	6.5 (2)
Pediatric	8.1 (1.05)	7.91 (2.07)	8.65 (3.44)
Labor & Delivery	23.08 (5.11)	21.81 (7.42)	18.14 (7.01)
OB Acute	5.71 (1.47)	6.12 (3.62)	7.05 (3.8)
Sub-acute Care	N/A	6.11 (0.79)	4.52 (1.64)
Psychiatric: Acute Care Hospitals	4.56 (1.3)	3.79 (0.98)	5.26 (2.15)
Psychiatric: Psychiatric Hospitals	6.16 (1.42)	N/A	3.37 (.97)

Table 10. ***Productive*** *licensed nursing hours* ***(RN, LVN) per patient day,*** *by urban-rural status.*

AB 394 Unit Type	**Mean Productive Hours (SD)**	
	.2.15.4.1 Urban-Rural Status	
	Rural Hospitals (n=66)	**Non-rural Hospitals (n=340)**
Critical Care	16.38 (3.15)	14.55 (3.75)
General Medical Care	7.25 (4.13)	5.13 (1.87)
Step-down / Telemetry	8.17 (2.35)	6.62 (2.03)
Pediatric Unit	6.35 (4.01)	8.6 (3.17)
Labor & Delivery	17.13 (6.95)	18.89 (7.09)
OB Acute	9.15 (4.23)	6.49 (3.48)
Sub-acute Care	4.45 (0.55)	4.62 (1.73)
Psychiatric: Acute Care Hospitals	6.18 (0.23)	5.05 (2.09)
Psychiatric: Psychiatric Hospitals	N/A	3.55 (1.30

Table 11. Productive **licensed nursing hours** per patient day, by **hospital ownership**.

AB 394 Unit Type	Mean Productive Hours/Patient Day (SD)					
	Church Mean (SD) (n =43)	**District Mean (SD) (n=41)**	**Government Mean (SD) (n=25)**	**Non-Profit Mean (SD) (n=163)**	**For-Profit Mean (SD) (n=126)**	**UC Mean (SD) (n=7)**
Critical Care	14.73 (2.48)	15.93 (2.96)	14.62 (2.49)	14.66 (2.92)	14.61 (3.46)	15.38 (2.04)
General Medical Care	5.43 (1.48)	7.13 (4.22)	5.38 (1.66)	5.49 (2.3)	4.88 (2.56)	6.05 (1.23)
Step-down/ Telemetry	6.83 (2.11)	8.6 (2.64)	8.78 (0)	6.55 (2.1)	6.03 (1.32)	7.86 (1.84)
Pediatric	9.1 (2.76)	7.69 (3.66)	7.98 (2.46)	8.83 (3.32)	7.92 (3.54)	8.91 (3)
Labor & Delivery	18.29 (7.42)	18.24 (8.11)	22.42 (8.76)	18.42 (7.17)	17.46 (5.32)	25.01 (4.19)
OB Acute	6.88 (4.3)	8.1 (3.26)	6.44 (4.19)	7.24 (3.89)	6.22 (3.29)	5.28 (1.04)
Sub-acute Care	5.18 (0.91)	4.26 (0.47)	4.95 (0)	4.6 (2.19)	4.3 (0.9)	0 (0)
Psychiatric: Acute Care Hospitals	4.58 (1.22)	5.85 (1.65)	4.04 (1.50)	5.38 (2.07)	4.92 (2.53)	3.83 (0.44)
Psychiatric: Psychiatric Hospitals	2.62 (0)	N/A	3.09 (0.63)	3.74 (1.41)	3.39 (.94)	6.97 (0.18)

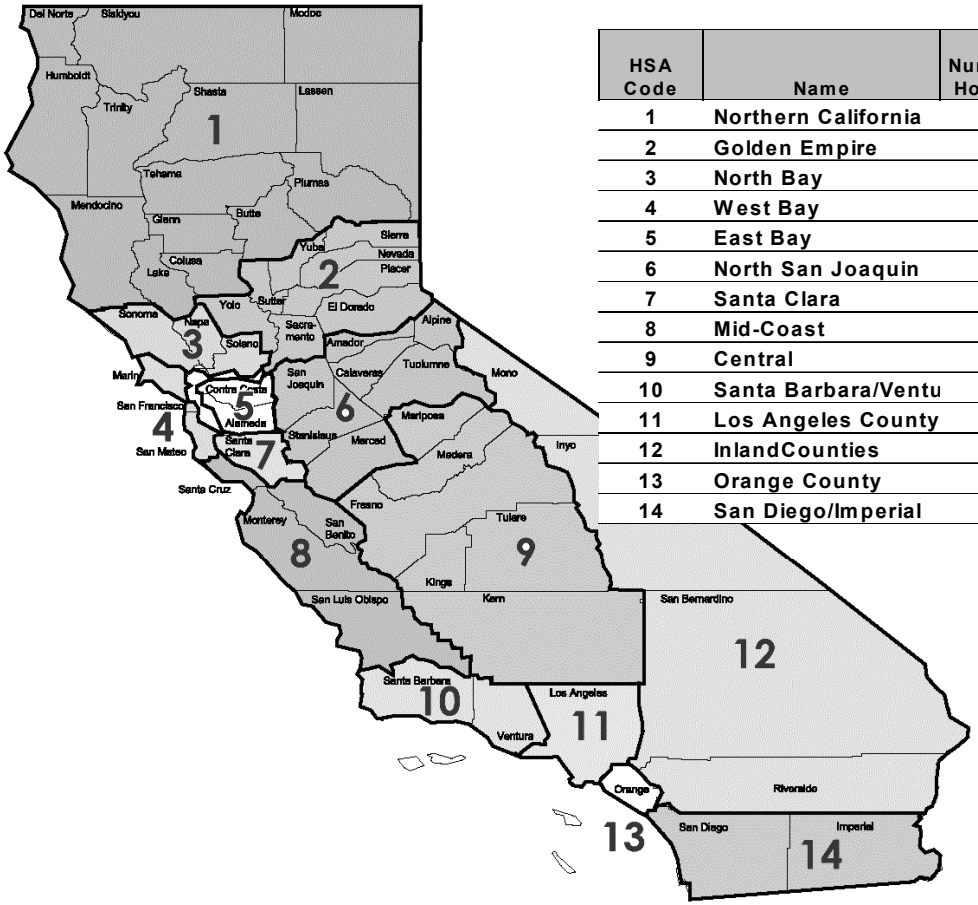
Table 12. Productive **licensed nursing hours** (RN, LVN) per patient day, by **OHSPD Health Services Areas**

AB 394 Unit Type	Productive Hours/Patient Day						
	Central Mean (SD) (n=30)	East Bay Mean (SD) (n=21)	Golden Empire Mean (SD) (n=21)	Inland Counties Mean (SD) (n=41)	Los Angeles County Mean (SD) (n=103)	Mid-Coast Mean (SD) (n=14)	Northbay Mean (SD) (n=14)
Critical Care	14.80 (2.33)	14.92 (1.85)	15.01 (1.88)	14.28 (2.31)	13.89 (3.3)	15.03 (3.76)	15.54 (1.54)
General Medical Care	6.34 (4.1)	5.94 (1.64)	5.95 (1.04)	5.36 (1.9)	4.67 (1.46)	5.65 (1.63)	5.14 (1.04)
Step-down/ Telemetry	6.85 (3.95)	7.62 (1.43)	6.64 (1.02)	6.24 (1.96)	6.35 (1.92)	7.76 (1.51)	5.67 (0)
Pediatric	7.68 (3.88)	10.85 (2.66)	8.6 (1.15)	8.21 (3.23)	8.03 (2.99)	10.68 (5.08)	10.62 (3.53)
Labor & Delivery	14.51 (6.5)	21.74 (5.95)	18.89 (4.89)	19.77 (6.04)	18.53 (7.33)	19.06 (7.45)	20.35 (5.98)
OB Acute	7.32 (2.97)	6.46 (2.9)	7.44 (4.21)	6.12 (2.48)	5.66 (2.47)	6.82 (2.91)	6.54 (4.59)
Sub-acute Care	4.26 (0.3)	N/A	4.8 (0)	4.11 (0.35)	4.7 (2.49)	N/A	6.67 (0)
Psychiatric: Acute Care Hospitals	5.17 (1.45)	6.92 (3.63)	7.61 (3.13)	5.92 (1.63)	4.36 (1.73)	6.33 (3.65)	5.9 (3.49)
Psychiatric: Psychiatric Hospitals	3.14 (0)	2.81 (1.31)	2.57 (0.51)	3.75 (0.85)	3.47 (1.49)	3.7 (0)	3.41 (0.65)

Table 12. (continued)

AB 394 Unit Type	Productive Hours/Patient Day						
	North San Joaquin Mean (SD) (n=21)	Northern California Mean (SD) (n=30)	Orange County Mean (SD) (n=34)	San Diego/ Imperial Mean (SD) (n=28)	Santa Barbara/ Ventura Mean (SD) (n=18)	Santa Clara Mean (SD) (n=11)	West Bay Mean (SD) (n=19)
Critical Care	15.29 (2.20)	15.9 (2.96)	13.91 (2.5)	16.39 (3.43)	16.04 (3.96)	14.6 (2.61)	15.30 (3.46)
General Medical Care	5.02 (2.04)	7.82 (4.57)	4.75 (0.9)	5.36 (0.8)	5.13 (1.61)	4.49 (1.15)	7.32 (4.88)
Step-down/ Telemetry	6.11 (2.03)	8.33 (2.18)	6.13 (1.2)	7.63 (2.61)	3.91 (1.9)	8.04 (1.66)	9.02 (1.88)
Pediatric	9.13 (1.43)	9.89 (4.63)	7.28 (1.97)	8.56 (2.38)	7.59 (3.13)	9.19 (3.52)	8.22 (4.89)
Labor & Delivery	14.65 (8.05)	17.84 (7.42)	20.12 (8.31)	21.73 (6.93)	15.33 (6.39)	15.42 (3.28)	24.6 (5.94)
OB Acute	8.38 (4.72)	10.47 (5.47)	5.83 (2.74)	5.19 (1.26)	8.73 (5.22)	5.86 (1.8)	10.39 (5.05)
Sub-acute Care	4.67 (0.26)	N/A	4.17 (0)	4.34 (0.32)	4.08 (0.39)	4.32 (0)	5.57 (1.75)
Psychiatric: Acute Care Hospitals	6.34 (0)	5.08 (0)	4.5 (1.83)	4.77 (0.99)	5.45 (1.67)	6.36 (.55)	4.54 (1.2)
Psychiatric: Psychiatric Hospitals	2.6 (0.05)	N/A	3.05 (2.80)	3.81 (0.56)	3.74 (0.94)	4.92 (0)	5.53 (1.86)

Figure 6. Licensed nurse staffing levels in general medical care units within California's 14 health services areas.



HSA Code	Name	Number of Hospitals	PHPPD for General Med Units
1	Northern California	30	7.8
2	Golden Empire	21	5.6
3	North Bay	14	5.1
4	West Bay	19	7.3
5	East Bay	21	5.9
6	North San Joaquin	21	5.0
7	Santa Clara	11	4.5
8	Mid-Coast	14	5.7
9	Central	30	6.3
10	Santa Barbara/Ventu	18	5.1
11	Los Angeles County	103	4.7
12	InlandCounties	41	5.4
13	Orange County	34	4.8
14	San Diego/Imperial	28	5.4

Table 13. Proportion of nursing units (hospital cost centers) projected in "substantial deficit" under various AB 394 proposals.

Unit Type	Original AB 394	CHA	CNA	SEIU	UC (actual)	UNAC
Gen Med Care	16%	4%	92%	76%	16%	76%
Definitive Observation	46	0	75	75	5	75
Pediatrics	48	5	48	48	8	48
Psychiatry units in acute care hospitals	--	0	77	92	--	57
Psychiatry units in psychiatric hospitals	--	4	93	96	--	85
Subacute care	24	0	90	79	--	79

Table 14. Number of additional productive licensed nursing hours needed to make up deficits under various AB 394 proposals.

Unit Type	Original AB 394	CHA	CNA	SEIU	UC (actual)	UNAC
Gen Med Care	781,710	198,197	16,952,999	6,433,982	781,710	6,433,982
Step Down / Telemetry*	565,731	0	2,068,763	2,068,763	36,187	2,068,763
Pediatrics	364,231	6,762	364,231	364,231	16,512	364,231
Psychiatry units in acute care hospitals	--	0	1,450,503	2,913,548	--	685,137
Psychiatry units in psychiatric hospitals	--	498	1,318,393	2,318,915	--	748,863
Subacute care	75,489	0	646,535	261,456	--	261,456

* When separate step down and telemetry standards were specified, the (usually leaner) telemetry ratio was used for the calculation. OSHPD data do not distinguish between step down and telemetry; both are assigned to the "definitive observation" cost center.

Table 15. Number of licensed nurse FTEs needed to make up deficits in productive hours under various AB 394 proposals.*

Unit Type	Original AB 394	CHA	CNA	SEIU	UC (actual)	UNAC
Gen Med Care	460	117	9973	3,785	460	3,785
Step Down / Telemetry*	333	0	1,217	1,217	22	1,217
Pediatrics	215	4	215	215	10	215
Psychiatry units in acute care hospitals	--	0	854	1714	--	404
Psychiatry units in psychiatric hospitals	--	1	776	1365	--	441
Subacute care	45	0	381	154	--	154

* Notes: 1) Number FTEs calculated by dividing deficit (in hours) by productive hours in a year (.85*2000=1700). 2) When separate step down and telemetry standards were specified, the (usually leaner) telemetry standard was applied.

Table 16a. Number of hospitals in deficit and projected deficits (in dollars) under varying AB 394 proposals.

Unit Type	Original AB 394		CHA		CNA		SEIU		UC (actual)		UNAC		CDHS	
	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)
Gen Med Care*	53/334	22,427	11/334	5,702	308/334	488,600	254/334	184,718	53/334	22,427	254/334	184,718	53/334 131/334	22,427 56,186
Step Down/ Telemetry**	60/129	16,214	0/129	0	97/129	59,959	97/129	59,959	6/129	1,020	97/129	59,959	14/129	2,933
Pediatrics	72/149	10,722	7/149	219	72/149	10,722	72/149	10,722	12/149	511	72/149	10,722	29/149	2,002
Psychiatry units in acute care hospitals	--	--	0/115	0	4/115	42,686	106/115	85,926	--	--	65/115	20,236	34/115	9,838
Psychiatry units in psychiatric hospitals	--	--	2/46	15	44/46	36,838	46/46	64,595	--	--	41/46	21,106	32/46	11,875
Subacute Care	9/38	1,737	0/38	0	34/38	14,741	30/38	5,969	--	--	30/38	5,969	---***	---

*Top estimate using 1:6 ratio, bottom estimate using 1:5 ratio

**Using the telemetry ratio

***No proposal; commencing January 1, 2002, the nurse-to-patient ratio in a Subacute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.

Notes:

1) A full time equivalent nurse was assumed to work 2000 hours per year, of which 1700 hours (85%) are assumed to be productive.
2) In this Table, a hospital is counted in deficit if it is >= 1 productive hour below the relevant standard. This is in contrast to the results of Table 13, where a hospital must be more than 5% below the standard to be counted as in "substantial deficit."

Table 16b. Number of hospitals in deficit and projected adjusted deficits (in dollars) under varying AB 394 proposals,

Unit Type	Original AB 394		CHA		CNA		SEIU		UC (actual)		UNAC		CDHS	
	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)	Hosps: Def/Tot	Adjusted Deficit ($1000s)
Gen Med Care*	53/334	32,082	11/334	8,036	308/334	573,422	254/334	245,673	53/334	32,082	53/334	32,082	53/334 131/334	32,082 80,070
Step Down/ Telemetry**	60/129	23,817	0/129	0	97/129	76,546	97/129	76,546	6/129	1,701	60/129	23,817	14/129	4,463
Pediatrics	72/149	16,769	7/149	599	72/149	16,769	72/149	16,769	12/149	1,157	72/149	16,769	29/149	3,964
Psychiatry units in acute care hospitals	--	--	0/115	0	4/115	58,824	106/115	115,366	--	--	--	--	34/115	13,634
Psychiatry units in psychiatric hospitals	--	--	2/46	119	44/46	50,803	46/46	88,581	--	--	--	--	32/46	16,664
Subacute Care	9/38	2,934	0/38	0	34/38	23,177	30/38	10,044	--	--	9/38	2,934	---***	---

*Top estimate using 1:6 ratio, bottom estimate using 1:5 ratio

**Using the telemetry ratio

***No proposal; commencing January 1, 2002, the nurse-to-patient ratio in a Subacute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.

Notes:

1) A full time equivalent nurse was assumed to work 2000 hours per year, of which 1700 hours (85%) are assumed to be productive. To generate deficit amounts for this table, we assumed that nurses could only be hired in full-time equivalent units. Under this assumption, any hospital that falls below the staffing threshold would need to hire at least one full-time nurse.
2) In this Table, a hospital is counted in deficit if it is >= 1 productive hour below the relevant standard. This is in contrast to the results of Table 13, where a hospital must be more than 5% below the standard to be counted as in "substantial deficit."

3) All dollar estimates were adjusted upward to 2000-2001, based on: (1) the National Compensation Survey of mean hourly earnings (salary only) by nurses in 6 metropolitan areas in California (Los Angeles-Riverside-Orange, Sacramento-Yolo, Salinas, San Diego, San Francisco-Oakland-San Jose, Visalia-Tulare-Porterville), weighted in accord with the total employed population in these areas; and (2) the survey of Employer Costs for Employee Compensation among civilian workers nationwide (fringe benefits only). Estimates were generated separately for registered nurses and licensed practical nurses, and then weighted based on the average skill mix among all units of the same type. Each hospital's costs were adjusted proportionately, assuming that the ratio of their average hourly nursing costs to the statewide average remained the same between 1998-1999 and 2000-2001. The assumptions inherent in these adjustments are that: (1) six metropolitan areas are representative of the entire state, (2) fringe benefit costs for nurses in California equal the national average, (3) hospitals did not change their unit-specific skill mix between 1998-1999 and 2000-2001, (4) nursing salaries did not change between the first and last National Compensation Surveys in California (i.e., December 1999 through March 2001).

4) Based on prior literature (Lichtig [1], Needleman [2]), as discussed on page II-13, we assumed that each additional hour of nurse staffing per patient day would shorten mean length of stay by 5.1% for acute care patients. We found no evidence of such an effect for psychiatric or subacute patients, and no evidence that increased nurse staffing lowers non-nursing costs.

.3.1 EXPERT PANEL PROCESS

Margaret Hodge, RN, EdD; Valerie Olson; Steven Asch, MD, MPH; Mary Jane Sauvé, RN, DNSc; Richard L. Kravitz, MD, MSPH

Nursing is both a science and an art:
its most important contributions are intangible.[1]

INTRODUCTION: SELECTION AND DEVELOPMENT OF NURSE-SENSITIVE INDICATORS

Nursing is a critical factor in determining the quality of care in hospitals and the nature of patient outcomes.[2] In the early 1990's, concerns regarding patient safety and the quality of patient care became more prevalent as a result of changes in the nursing workforce, leading to an increased focus on indicators of quality.[3] A variety of efforts to measure the relationship between nursing interventions, nurse staffing levels, and patient outcomes were designed according to the specific interests of the private sector (health-plans, providers, etc), public sector (legislative mandates), and various nursing organizations (ANA, CalNOC). Each of these sectors has disparate reasons for measuring these outcomes. These reasons include an interest in evaluating cost-effectiveness as well as identifying differences in quality of care. Thus, measuring nursing quality of care using nurse-sensitive indicators has grown in importance within healthcare research and industry.

Outcomes research is advocated as a means for providing information to support decisions in health care. Traditionally, outcomes are defined as the end result of a process, treatment, or intervention.[4] While not a new concept, evaluating the outcomes specifically associated with nursing care is a complex and multi-faceted issue. Ideally nurse-sensitive indicators should separate the contributions of nursing from those of other disciplines while meeting research criteria for validity and reliability. [5]

Analyzing the relationships between nursing interventions, nurse staffing levels, and patient outcomes is complicated for a number of reasons. One, the value that nursing adds to patient care is elusive, in large part because nurses coordinate and modify the care provided by others. [1] For example, rates of nosocomial infections are frequently used in measures of nursing quality and the measures used to assess these rates demonstrate high levels of reliability. However, holding nurses solely responsible for the development of infection appears questionable.[5] Second, there is no single source of data available with which to assess patient outcomes. Administrative data sets, while providing a relatively inexpensive source of data, are collected for billing or regulatory reporting purposes and may not provide the detail needed to fully reflect nursing care. Clinical data, obtained for example from chart reviews, would possibly provide more valid and reliable information but could be prohibitively expensive. [6] Finally, data on nurse staffing levels is limited, often aggregated at the hospital level, and may not accurately reflect either the amount or quality of nursing care provided at the unit level.

Despite a growing body of published measurement guides, quality report cards, and recent work to collect and analyze nursing outcomes data, the ANA points out that there is a continued lack of definitive data to show the links between nursing interventions, nurse staffing

levels, and patient outcomes.[2] As Brooten and Naylor [7] note, the question becomes what "nurse dose" is needed to demonstrate an effect on patient outcomes.

As noted in Section 1, our systematic review and abstraction of published research showed evidence of a relationship between nurse staffing and various outcomes, but no support for a specific nurse to patient ratio. To date, no outcomes with the goal of measuring the effect of changes in nurse-patient ratios have been identified. In addition, while many of the studies reported a statistically significant relationship between nurse staffing and patient outcomes, interpreting the clinical significance of those relationships was difficult at best. Despite these limitations and oft-cited concerns that connections between outcomes and quality measures are not well understood [2,5], the outcomes identified in literature on the effects of nurse staffing may show promise for use in future evaluations on the impact of AB 394. Therefore, the purpose of this phase of the project was to identify nurse-sensitive indicators with the potential for use in the evaluation of specified nurse-to-patient ratio regulations.

METHODS

Developing the Panel Process

The modified Delphi expert panel process developed by RAND has been used historically to determine the appropriateness of specific medical procedures, such as indications for coronary artery bypass graft. This process then progressed to more general use, for example in evaluating quality of care or determining the best way to triage patients in the emergency department. Use of the modified Delphi expert panel process to identify indicators for evaluating structural predictors of quality, i.e., nurse staffing, is an innovative approach which has not previously been reported.

In consultation with a RAND researcher who has implemented 14 expert panels, project staff developed a panelist and moderator selection plan, panel process guidelines, and a list of indicators potentially sensitive to changes in nurse staffing. The steps of this process included:

1) Construction of indicators using evidence generated in the literature review.
2) Recruitment and selection of moderator and panelists.
3) Pre-rating: review of evidence, addition or changes to indicators or definitions, and initial anonymous rating.
4) Panel meeting: discussion and revision of definitions and indicators, and execution of final ratings.
5) Tabulation of results.

.4.1 Construction of Indicators

Potential indicators were derived from outcomes presented in the evidence tables (see Section 1, Systematic Review of the Literature, Evidence Tables, pp 30 - 100). Selecting the relevant indicators to be included was decided: a) by an extensive review of the literature, b) in consultation with other investigators, and c) based on clinical expertise of the project staff. Definitions of key terms were developed using the original studies, other relevant literature, and

expertise in medical and clinical concepts. Two institutional outcome indicators not displayed in the evidence tables (3e and 3f) were added. Definitions of turnover, vacancy rates, use of overtime, use of mandatory overtime, and nursing personnel costs were developed after consulting with a hospital financial administrator.

Each indicator had two components: the definition and a method for obtaining the data. The outcome was expressed as the incidence or rate of a particular condition or effect, such as *rates of nosocomial urinary tract infections*. Methods for obtaining data include use of *clinical data such as that obtained from chart review* or use of *administrative data such as existing data sets or administrative reports*. Therefore, for each outcome, two indicators could be generated. For example, a patient outcome of urinary tract infection would lead to the following two indicators, 1) *rates of nosocomial infections, as determined by clinical data,* and 2) *rates of nosocomial infections as determined by administrative data*. The purpose of including various definitions as well as methods of data collection was to provide the California Department of Health Services with a wide range of options for evaluating AB 394.

.5.1 Panel and Moderator Recruitment and Selection

The AB 394 project team initially met with a researcher from RAND to identify criteria for selection of the moderator and panelists, determine the size of the expert panel, and establish the process to be used for rating the indicators. Subsequent meetings were held in which the process and selection criteria were further refined.

The role of the moderator is critical to the success of the expert panel process. Prior to selecting the panelists, the project team met to identify potential moderators. Dr. Kathleen Dracup, Dean of the University of California, San Francisco School of Nursing, was selected based on her skill at facilitating meetings, expertise in nursing, and stature within the nursing community.

After careful consideration, the following panelist selection criteria were agreed upon:

1. The panelists selected should represent various geographic regions as well as hospital types.
2. Every effort would be made to assure clinical diversity, reflecting the nursing unit specialties specified in the AB 394 legislation.
3. A panel of 9 participants would allow for maximum diversity and is one of two standard panel sizes used for the modified Delphi expert panel process.

In order to limit bias, panelists would be selected from nominees provided by professional nursing and health care organizations. Organizations contacted for nominees included the American Nurses Association/California, Peri-anesthesia Nurses Association of California, Medical-Surgical Nurses Association, The Emergency Nurses Association, and Society of Pediatric Nurses. Each organization was asked to provide a list of four nominees, preferably with current clinical practice, administrative experience, and adequate educational preparation. Project staff selected six clinical nurses, representing a broad range of clinical expertise (medical-surgical, pediatric, emergency, and peri-anesthesia nursing) and geographic locations (Northern and Southern California, San Francisco Bay Area, and the Desert Region).

A doctorally prepared nurse researcher was selected based on extensive experience in the area of nurse staffing and patient outcomes. Finally, of the two hospital executives selected, one was a nurse and the other a physician. Panelists (Appendix 3: Table A) included representatives of the various hospital types including academic medical centers, small rural hospitals, large county hospitals, private hospitals and a large health maintenance organization.

.6.1 Pre-rating Materials and Process

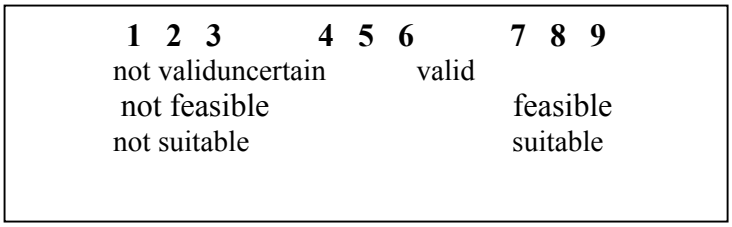
The pre-rating process was designed to allow panelists an opportunity to review the evidence, perform an initial anonymous rating of the indicators, suggest changes to the indicators or key term definitions, and to submit additional indicators for consideration. Approximately 3 weeks before the meeting, panelists received a packet containing the systematic literature review and evidence tables, a copy of the AB 394 legislation as chaptered, the ratings forms, a glossary of key terms, and instructions for the anonymous pre-rating exercise. Pre-ratings forms contained 70 indicators and 35 concept definitions. The forms were organized according to the outcome categories established during the literature review: patient outcomes (10 subsections, 55 indicators), employee outcomes (5 indicators), and institutional outcomes (10 indicators).

Before rating the indicators, panelists were instructed to review a draft of the systematic literature review and evidence tables, carefully examine the strength of the evidence supporting the choice of each indicator, review the rating dimensions, and consider appropriateness of each key term definition. The rating dimensions and ratings scale were described for the panelists, according to the objectives of the indicator selection process:

Figure 1. Ratings Dimensions

Dimension	Definition
Validity:	The extent to which the indicator is a sensitive and specific measure of the impact of nursing care on important clinical outcomes. A highly *valid* indicator will measure important outcomes that are relatively sensitive to changes in nurse staffing and relatively insensitive to other patient, provider, and institutional factors. A highly *invalid* indicator is only weakly related to nursing care, is strongly influenced by other factors besides nursing care, and/or focuses on unimportant outcomes.
Feasibility:	The extent to which the indicator can be measured quickly and economically. A highly *feasible* indicator is based on readily available public data. An *infeasible* indicator relies on data that would be prohibitively difficult or expensive to collect.
Overall suitability:	The extent to which the indicator ought to be considered for inclusion in the Department of Health Services' final package of AB 394 outcomes indicators. A highly *suitable* indicator should be strongly considered by DHS. A highly *unsuitable* indicator ought not to be considered at all.

Figure 2. Interpretation of Ratings Scale



When assessing the value of an indicator and making ratings along the three dimensions, panelists were asked to think of a group of average patients in an average California acute care hospital.

In addition to performing their pre-rating, panelists were invited to suggest changes to the wording of the indicators and key terms and to suggest additional indicators (accompanied by definitions) as appropriate. Even if they suggested modifications to key terms or definitions, panelists were asked to pre-rate all indicators as written on the ratings forms. To take advantage of the diverse clinical and administrative expertise of our panel, we encouraged panelists to suggest additional indicators from published or unpublished evidence relevant to nurse staffing. We pointed out that our systematic review was limited to articles indexed under terms relating to nurse staffing, and that we conducted a limited investigation of literature indexed under certain outcomes which yielded only a few articles of interest. If panelists wished to submit indicators for which no available research findings or evidence existed, they were instructed to provide a brief rationale and justification for their choice as well as a working definition as necessary.

Before submitting their pre-rating forms to the project manager, panelists were instructed to confer briefly with either one of the Principal Investigators. This check-in process was designed to ensure that panelists had an opportunity to clarify any questions they might have about the ratings process, the indicator concepts, or key terms. Panelists were encouraged to modify their ratings as necessary after these discussions.

.7.1 Meeting Groundwork

Prior to the expert panel meeting, the pre-rating distributions and median scores were tabulated using Microsoft Excel spreadsheets and a Microsoft Access program developed by RAND. Re-rating forms were identical to the pre rating forms, with the addition of the pre-rating distributions and medians and a new sub-section containing five additional patient outcomes indicators suggested by one panelist. Project staff also customized the final ratings forms so that each panelist could confidentially view his or her own rating alongside the anonymous ratings of other panel members.

As the success of an expert panel is influenced in part by the facilitation skills and preparation of its moderator, project staff met with the moderator the evening before the final rating meeting. Project staff reviewed and confirmed the meeting agenda, processes and ground rules. In addition, the moderator previewed the pre-rating results. On the day of the meeting, Dr. Dracup was introduced as the panel moderator and the meeting was turned over to her.

.8.1 Meeting: Final Rating Process

During a day-long meeting on May 15, 2001, in Sacramento, California, the panel reviewed, discussed, and re-rated each of the potential indicators. As a result of the limitations described previously, we relied on our expert panelists to extend the literature and use their clinical expertise to choose the most valid, reliable, and suitable among the indicators identified. In addition, we asked each panelist to discuss the various definitions provided for each indicator with the goal being that the panel would reach consensus on the definitions. Panelists were again invited to suggest additional indicators broad enough for use hospital wide or narrow and unit-specific such as those appropriate for measuring the quality of nursing care in the emergency department.

Members of the AB 394 project team were in attendance but did not participate in the discussions or ratings. The role of the project team was to provide additional information/resources, answer questions, and clarify of the process as needed.

At this meeting, panelists reviewed and clarified definitions and re-rated the indicators for validity, feasibility, and suitability. During the rating session, panelists were reminded that a rating of "9" meant the indicator met the criteria for validity, feasibility, or suitability. A rating of "1" meant the indicator did not meet the criteria and a rating of "5" meant that it might meet the criteria. Panelists were asked to rate an indicator "1-3" or "7- 9" when possible and to avoid mid-level ratings when possible.

Definitions for the key terms and concepts of each outcome were discussed one at a time, section by section, followed by a discussion of the associated indicators. Changes to definitions were recorded by project staff and reiterated by the moderator before panelists rated the indicators. Final definitions as approved by consensus are listed in Appendix 3: Table B. After discussing each section, the panelists completed their final ratings. Indicators receiving a median score of 7 or greater were considered suitable. Disagreement was noted when 2 or more of the ratings occurred at the opposite end of the rating scale. For example, if an indicator received a median score of 8, yet 2 individuals rated the indicator as a 2, this indicator would be identified as disagreement. With only 9 panelists, it was statistically unlikely that an indicator would have extreme ratings from 2 or more, simply by chance. Therefore, those indicators were excluded as suitable and were included in the list of potentially suitable indicators.

RESULTS AND DISCUSSION

.9.1 Qualitative Results

Throughout the meeting, panelists participated in extensive debate on each of the definitions, the realities of obtaining the data, and the extent to which an indicator was believed to be sensitive to changes in nurse-to-patient ratios, with particular attention paid to this last issue. Repeatedly, the panel would evaluate whether or not a particular indicator was in fact sensitive to changes in nurse-to-patient ratios.

In the course of its deliberations, the panelists focused on the following issues:

- Definitions of indicators should be based on nationally recognized criteria. Thus the panelists referred to the CDC guidelines for the definitions of various nosocomial infections and the AHRQ National Pressure Ulcer Guidelines for definitions of noscomial pressure ulcers (see glossary). In addition, the work of CalNoc was recognized as providing guidance in defining various terms. Furthermore, the panelists felt that when new indicators were identified, nationally recognized definitions should be used.

- In many instances, patient outcomes are influenced by factors beyond the control of nursing. Therefore, identifying outcomes in which nursing care plays a substantial role and for which nurses have primary control is critically important.

- Some outcomes, while associated with nurse staffing levels, may not be sensitive to changes in nurse-to-patient ratios and therefore may not be appropriate for evaluating the impact of AB 394. For example, while patient falls have been used as a patient outcome in previous research on nurse staffing, the panel's final ratings indicate that they did not feel this particular indicator would be appropriate to measure quality with respect to changes in the licensed nurse-to-patient ratio. During discussion, panelists noted that differences in utilization of licensed and unlicensed staff might be a more significant source of variation in this outcome.

- It was acknowledged that evaluating patient outcomes with clinical data may provide the most accurate and valid information, this was in general a time consuming and expensive process. Use of administrative data was felt to be more feasible although the panelists felt that the burden to the institution of collecting additional administrative data should be considered.

.10.1 Quantitative Results

The final ratings for all indicators are presented in Appendix 3: Tables C – E. The first column contains the indicator; italicized terms can be found in the index. The next three columns to the right represent the dimensions on which the indicators were rated. To the right of each indicator, and within each column, are three rows that display the ratings results. The bolded middle row represents each of the points on the nine-point scale. Above each number in this scale is the number of panelists who rated an indicator at that point in the scale. The bottom row contains the median score. If the letter "D" appears to the right of the median, disagreement is present in the rating; otherwise the ratings pattern indicates no disagreement.

Table 1 below summarizes the final ratings for *suitable indicators*. On the nine-point scale, 9 of the 79 indicators (11%) were given a rating of 7 or more without disagreement. For the categories of patient outcomes, 7 of 60 indicators (12%) were given a rating of 7 or more, while of the employee outcomes, 2 of 8 (25%) were given a rating of 7 or more. None of the 9 institutional outcomes were considered suitable. As noted in Section 1, the strongest evidence of a link between nurse staffing levels and patient outcomes exists for the following indicators:

mortality, pneumonia, and length of stay. Two of these, mortality and length of stay, were rated as suitable indicators, while a third, pneumonia, was rated as potentially suitable. The outcomes demonstrating the weakest evidence of a link between nurse staffing and patient outcomes were rejected.

Table 2 below summarizes the final ratings for *potentially suitable indicators*. Indicators are considered potentially suitable if they received an overall suitability score of 7 or greater with disagreement, or 5 or 6 with or without disagreement.

.11.1 DISCUSSION AND RECOMMENDATIONS

.12.1 Discussion

During their day-long meeting, panelists engaged in a productive exchange of ideas relative to evaluating the impact of AB 394. Their ratings suggested 9 suitable indicators with an additional 14 identified as being potentially suitable. They modified definitions for 9 indicators, and suggested an additional 11 indicators of which 5 were rated either suitable or potentially suitable.

It is recognized that this process does have limitations that must be considered when interpreting the results. First, there was inconsistent agreement on ratings. In a few instances, a minority of panelists would rate an indicator very low, although the majority indicated a high rating. In addition, although a rating may have received high ratings for validity and feasibility, it may have been rated low on suitability. This may be related to the panelists' concern that a suitable indicator had to be sensitive to changes in nurse-to-patient ratios. The second limitation was the very short time-line for this project, which limited opportunities for exploring additional indicators.

Despite these limitations, use of the expert panel process proved useful in identifying indicators suitable for evaluating AB 394. The clinical, geographic, and hospital type diversity represented by the panelists provided an opportunity for a wide range of opinions and the views expressed encompassed many of issues that must be considered.

.13.1 *Future Directions*

Based on the results of this process, the following recommendations are made:

- While the panel provided ratings on the validity, feasibility and suitability of each indicator, the ratings of validity and overall suitability should remain the major focus. Ratings of feasibility should be used only as a rough guide as to the appropriateness of a given indicator.
- There is a need for additional indicators that would be appropriate for evaluating nurse-to-patient ratios in specific areas such as the emergency department, post-anesthesia care unit, and labor and delivery.

- The majority of indicators are based on adverse events such as rates of nosocomial infections. There is a need for additional positive indicators, such as patient's satisfaction with the quality of care.
- Prior to state-wide implementation, there is a need for pilot studies using these indicators to evaluate nurse-to-patient ratios.
- As additional measures of nursing quality of care are identified, their suitability for evaluating changes in nurse-to-patient ratios will be important.
- Operational definitions for each of the indicators rated as suitable or potentially suitable need to be established.

In summary use of the modified Delphi Expert Panel process led to nine indicators that were considered valid, feasible, and suitable outcomes for evaluating the impact of AB 394. In addition, 14 other indicators were rated highly on important dimensions and could be considered for use in the evaluation process. As noted previously, the use of this process for assessing structural components of care, such as nurse staffing, is an innovative use of the modified Delphi approach. The results of this phase of the project demonstrates that this is a valid method for identifying indicators appropriate for use in outcomes research with a focus on structural predictors of quality in health care.

. 1 3 . 1 . 1 . 1 *REFERENCES*

1. Melberg, S.E. Effects of Changing Skill Mix. *Nursing Management* **1997** 28(11), 47-48.

2. American Nurses' Association. *Nursing Quality Indicators: Guide for Implementation* (2nd ed.). Washington, D.C.: American Nurses' Association, **1999.**

3. Verran JA. Quality of care, organizational variables, and nurse staffing. In: Wunderlich, GS, Sloan FA, Davis CK, editors. *Nursing Staff in Hospitals and Nursing Homes: Is It Adequate?* Institute of Medicine, Division of Health Care Services. Washington DC: National Academy Press, 308-32. **1996.**

4. Houston, S. Getting Started in Outcomes Research. *AACN Clinical Issues* **1996**, 7(1), 146-152.

5. Higgins, M., McCaughan, D., Griffiths, M., & Carr-Hill, R. Assessing the Outcomes of Nursing Care. *Journal of Advanced Nursing* **1992**, 17, 561-568.

6. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelvinsky K. Nurse Staffing and patient Outcomes in Hospitals. Final Report of US DHHS Health Resources and Services Administration Contract No. 230-99-0021, Feb, **2001**.

7. Naylor M, Brooten D, Jones R, Lavizzo-Mourey R, Mezey M, Pauly M. Comprehensive discharge planning for the hospitalized elderly: a randomized clinical trial. *Ann Intern Me*d **1994**;120:999-1006.

Table 1. Suitable Indicators for Evaluating Changes in Nurse to Patient Ratios. Indicators receiving an overall suitability score of 7 or more with no disagreement (D=disagreement, A=agreement)

Indicator Category	.13.2.1 Indicator	Validity median, (agreement)	Feasibility median, (agreement)	Overall Suitability median, (agreement)
Patient Outcomes	F1. Risk adjusted mortality, overall, determined using administrative data	6 (D)	8 (A)	7 (A)
	G2. Hospital length of stay, medical patients	7 (A)	8 (A)	7 (A)
	H1. Failure to rescue, determined using clinical data	8 (A)	5 (D)	7 (A)
	H2. Failure to rescue, determined using administrative data	7 (A)	8 (A)	7 (A)
	I1. Patient satisfaction, determined using a survey	7 (A)	8 (A)	8 (A)
	I2. Patient satisfaction with pain management, determined using a survey	8 (A)	8 (A)	8 (A)
	J2b. Completion of patient teaching, determined using a survey	7 (A)	7 (A)	7 (A)
Employee Endpoints	2e. Perceptions of quality of care, as perceived by nurses, determined using a survey	8 (A)	8 (A)	7 (A)
	2Af. Work-related injuries, musculo-skeletal (added by panel)	7 (A)	7 (A)	7 (A)

Table 2. Possibly Suitable Indicators for Evaluating Changes in Nurse to Patient Ratios: Indicators receiving an overall suitability score of 5 – 6 with or without disagreement or 7 or more with disagreement (D=disagreement, A=agreement)

Indicator Category	Indicator	Validity median, (agreement)	Feasibility median, (agreement)	Overall Suitability median, (agreement)
Patient Outcomes	A4a. Rates of hospital acquired pneumonia, post-operative patients, determined using clinical data	5 (D)	4 (D)	5 (D)
	A4b. Rates of hospital acquired pneumonia, post-operative patients, determined using administrative data	5 (D)	7 (D)	5 (A)
	A5. Rates of bacteremia associated with sites of central lines, determined using clinical data.	7 (D)	5 (D)	6 (D)
	C1a. Rates of nosocomial pressure ulcers among all hospitalized patients, determined using clinical data.	7 (A)	4 (D)	6 (D)
	C2a. Rates of nosocomial pressure ulcers among medical patients, determined using clinical data.	7 (D)	4 (D)	5 (D)
	G1. Hospital length of stay, all patients	6 (D)	8 (A)	7 (D)
	G3. Hospital length of stay, surgical patients	4 (D)	8 (A)	5 (D)
	J2a. Documentation of patient teaching, determined using clinical data	8 (A)	4 (D)	6 (D)
Employee Endpoints	2b. Nurse satisfaction, determined using a survey	7 (A)	7 (A)	6 (D)
Institutional Endpoints	3a. Turnover, determined using a hospital survey	7 (A)	8 (A)	6 (D)
	3c. Use of overtime,	6	8	6

	determined using a hospital survey	(D)	(A)	(D)
	3g. Nursing personnel costs per patient day, determined using a hospital survey	6 (D)	8 (A)	5 (D)
	3Ak. Actual staffing vs. minimal (mandated) staffing	7 (A)	7 (A)	6 (D)
	3Al. Tracking use of non-licensed personnel FTEs	6 (D)	7 (A)	7 (D)

.13.2.1.1

Patrick S. Romano, MD, MPH; Richard L. Kravitz, MD, MSPH, Valerie A. Olson; Steven J. Samuels, PhD; Danielle J. Harvey, PhD; Julie A. Cahill, MPH; Margaret Hodge, RN, EdD; Mary Jane Sauvé, RN, DNSc; Regina Henning, BSN, PHN; Ruth Bedwell, BSN, PHN

Introduction

This report provides our analysis of nurse staffing survey[3] data collected by the Department of Health Services Licensing and Certification (DHS L&C) staff from a stratified probability sample of California acute care hospitals. Although the yearly OSHPD Hospital Disclosure report contains data that can be used to estimate productive licensed nurse hours per patient day, these data are aggregated at the cost-center level and cannot be converted to patient-to-nurse ratios for specific shifts on specific units (see Section II). Therefore, the DHS decided to collect data directly from a sample of hospitals at the nursing unit level, in order to understand current staffing patterns better and to explore the implications of variability in staffing across nursing units, days, and shifts. The onsite survey, designed collaboratively by DHS L&C and UC Davis Center for Health Services Research in Primary Care (UCD CHSR/PC) project staff, was designed to collect cross-sectional data on hospitals' nursing workforce and staffing practices, and to assess patient-to-nurse staffing ratios within selected unit types. The principal aims of the survey were to:

- Generate weighted estimates of the distribution of patient-to-nurse ratios, at the shift level, for selected nursing units in general acute care hospitals in California;
- Estimate the statewide nursing deficit (in FTEs) for general acute care hospitals in California, under various AB394 regulatory proposals;
- Estimate the financial impact associated with bringing general acute care hospitals into compliance with various AB394 regulatory proposals;
- Estimate, if possible, the relationship between patient-to-nurse ratios derived from the 2001 survey and comparable ratios estimated from 1998-99 OSHPD data (using productive licensed nurse hours per patient day).

DHS L&C contracted with the UC Davis Center for Nursing Research to analyze the results of a similar onsite survey of licensed nurse staffing in acute psychiatric hospitals. Results from this study are contained in a separate report.

[3] The term "survey" used in this analysis refers to the one-time onsite nurse staffing study conducted by DHS Licensing and Certification, and was not a routine enforcement survey as is commonly conducted by the L&C program.

Methods

.1.1 General Approach

In August 2000, the DHS sent a letter to all hospitals subject to regulation under AB394 to announce that an on-site staffing survey would be conducted statewide. This letter, signed by DHS Director Diana M. Bontá, informed hospitals that DHS staff would conduct a survey to ascertain current staffing practices in California hospitals. DHS L&C staff and surveyors were scheduled to conduct the survey in Spring 2001, and began to work with UCD CHSR/PC staff in November 2000 to design the sampling strategy, develop the survey tool, and plan for survey implementation.

DHS L&C staff determined the targeted types of nursing units based on the unit types specified in AB394, and modified this list to include combined or mixed units. The crosswalk appears below. Although postpartum units were not specified in the legislation, they were included in the survey so that it would be possible to gather staffing data in hospitals with discrete postpartum and labor and delivery units. Similarly, two different types of stepdown units and three different types of general medical care units were identified to facilitate sampling. A category for psychiatric units was added, so that nurse staffing data from psychiatric units in general acute care hospitals could later be compared with data collected from acute psychiatric hospitals (which are also subject to regulation pursuant to AB394). Specialty care units were defined as oncology units, because other types of specialty care units were believed, and subsequently confirmed, as being quite rare among general acute care hospitals

in California. Unit types with existing ratio regulations (i.e., critical care, operating room) were excluded from the survey. Burn units were also excluded, as DHS L&C staff anticipated that ratios for burn units would be set equal to those for critical care units.

AB 394 DESIGNATION	SURVEY UNIT
Critical Care Unit	*Not surveyed*
Burn Unit	*Not surveyed*
Labor and Delivery Room	Labor and Delivery, Postpartum, Combined Labor and Delivery and Postpartum
Postanesthesia Service Area	Postanesthesia
Emergency Department	Emergency
Operating Room	*Not surveyed*
Pediatric Unit	Pediatric
Step-Down/Intermediate Care	Stepdown, Combined Stepdown/Telemetry
Specialty Care Unit	Oncology
Telemetry Unit	Telemetry
General Medical Care Unit	Medical, Surgical, Combined Medical/Surgical
Sub-Acute Care Unit	Sub-Acute (Transitional) Inpatient
Transitional Inpatient Care Unit	Sub-Acute (Transitional) Inpatient
Not specified	Psychiatric
Not specified	Mixed Unit

The on-site survey was designed to collect staffing data for one randomly selected unit of each type within each hospital. This required surveyors to enumerate all of the units of each type within each sampled hospital, based on information provided by hospital administrators. After randomly selecting one unit of each type, surveyors interviewed nurse managers and direct care nursing staff on duty, and reviewed staffing logs, to ascertain the number of RNs, LVNs, unlicensed staff, and patients in each sampled unit at the beginning of the surveyed shift, for all shifts during the past seven days, and for all shifts on ten randomly selected days during the previous three months. In addition, surveyors collected data on the demographic and educational characteristics of each nurse on duty in each sampled unit, and supplemental information on hospital operations that might explain variations in staffing patterns. The survey methods are described in further detail below.

.2.1 Sample Design

The sample was designed to represent all general acute care hospitals licensed by the California Department of Health Services. Accordingly, hospitals operated by the Federal government were excluded from the sampling frame. AB394 requires that certain types of hospitals receive special consideration in the development and enforcement of nurse-to-patient ratios. Section 1276.4(a) of the Health and Safety Code stipulates that "flexibility shall be considered by the Department for rural general acute

care hospitals in response to their special needs," while section 1276.4(g) authorizes the Department to grant such hospitals waivers "that do not jeopardize the health, safety, and well-being of patients…and that are needed for increased operational efficiency…"

Because of the need to estimate current nurse staffing and project nursing deficits for these "special consideration" hospitals, we used stratified probability sampling. Each licensed hospital in California had a specified, non-zero probability of being sampled. Five sampling strata were specified, and rural, county, and academic hospitals were markedly oversampled to ensure that they would be adequately represented in the final sample. Kaiser hospitals were oversampled because their nurse staffing data were not available from the OSHPD Hospital Disclosure report. Specifically, we sampled all 10 academic medical centers (100%), 10 of 32 Kaiser hospitals (31%), 20 of 74 rural hospitals (27%), 10 of 25 public (city or county) hospitals (40%), and 30 of 341 other private hospitals (8.8%). The total sample included 80 hospitals. Four hospitals in our original sample had closed by the time of the on-site survey, and were replaced by randomly selected alternates in the same strata. All ten State-operated hospitals licensed by DHS were also surveyed, after the survey of academic, Kaiser, rural, public, and private hospitals was completed.

.3.1 Survey Tool Design and Implementation

To collect comparable data across all types of hospitals and units, we sought to develop a tool that could be implemented uniformly and universally. A limited search of published literature in December 2000 did not reveal any readily adaptable tools for a survey of this scope. However, the UCSF Center for the Health Professions' recent mail survey of acute care hospitals related to nurse staffing on medical-surgical units provided a conceptual framework (although the 27% response rate to this survey was too low to use their results).[1] The majority of questions were developed *de novo*, drawing on the expertise of project staff from DHS L&C and UC Davis. In addition, the Nursing Evidence Report Advisory Committee (NERAC) members were asked to review the final draft to ensure that the survey would be feasible and that the questions were valid; their suggestions were incorporated. Appendix 4 contains the tool, which was designed for automated data entry using scannable forms developed with Cardiff's Tele*form*™ software.

The survey instrument for each hospital was divided into four sections: a cover sheet, a unit inventory, a unit list and selection form, and the unit survey. The first section was designed to collect hospital-level data from hospital administrators, including the patient classification system used in acute care and psychiatric units and any information on recent structural changes that might have affected nurse staffing. Administrators were then asked to enumerate and name all units in each of the 16 unit categories listed above. DHS L&C staff

defined these unit types using Title 22 "general requirements," "care bed classifications," and "care service and unit definitions"; and other sources compiled during the instrument design process. The sources for each unit type definition are as follows: labor and delivery [Title 22 Section 70545], postpartum [Title 22 Section 70545], stepdown [American College of Critical Care Medicine, citation on file with L&C], medical [Title 22 Section 70201], surgical [Title 22 Section 70221], emergency [Title 22 Section 70411], pediatric [Title 22 Section 70535], psychiatric [Title 22 Section 70575], and post-anesthesia [Title 22 Section 70231]. To account for hospital units that served patients of more than one type, or did not match any of the specified unit types, we designated such units as "mixed."

The third section of the survey was the "Unit List and Selection Form." Surveyors listed all of the identified units of each type within each surveyed hospital, and then used one of 12 random number tables, randomly pre-assigned to each hospital, to select one unit of each type. That unit was then visited, and the nurse manager on duty and direct care staff nurses were interviewed. Surveyors first collected information about the current nursing shift, which was defined in terms of duration (8 hour, 12 hour, other) and time of day (day, evening, night, other). Nurse managers were asked about the number of patients, licensed nurses, and unlicensed assistive personnel present at the beginning of the current shift, and "usually" present on this shift. They were also asked about cumulative staffing and patient care activity (admissions and discharges) over the prior 24 hour census period. Surveyors also collected information about how various patient care functions are assigned to different staff, and what types of services are provided on the unit. In addition, nurse managers and direct care staff nurses were asked to provide data on the educational background, experience, employment status, and patient load of each nurse currently on duty in the unit.

In the final subsection of the survey, nurse managers from units other than emergency departments, postanesthesia units, and labor and delivery units were asked to provide staffing level and skill mix data (i.e., RNs, LVNs/PTs[4], unlicensed assistive personnel) for all shifts during the previous seven days, including any prior shifts on the day of the survey, and for all shifts on ten randomly selected days during the previous

[4] The abbreviation " PT" is used by the Board of Licensed Vocational Nurses and Psychiatric Technicians to refer to a licensed psychiatric technician.

three months. This information was obtained from staffing logs housed on the floor or from staffing log archives. The ten randomly selected days were the same for all surveyed hospitals, and represented a stratified combination of weekdays, weekend days, and holidays: the 1st, 10th, 13th, and 22nd of January 2001; the 8th, 18th, and 21st of February 2001; and the 9th, 11th, and 22nd of March 2001. This design allowed us to extrapolate nursing deficits from these dates to the entire calendar year, given our assumption that these months adequately represent the entire year. Surveyors collected data only on the current shift and the preceding 24-hour census period for emergency departments, postanesthesia care units, and labor and delivery units, because the patient census for these types of units varies from hour to hour, and is not recorded in a consistent manner.

Sixteen registered nurse surveyors experienced in healthcare facility data collection were selected to participate in this effort. All surveyors attended a six-hour training session by DHS L&C project staff, received a detailed protocol for reference in the field, and were instructed in how to handle unforeseen problems encountered in the field. Surveyors were able to contact lead DHS L&C project staff for technical and procedural support throughout the survey implementation period.

After pretesting the study tool at four local hospitals from four different sample strata, DHS L&C headquarters scheduled staff to perform the surveys unannounced and concurrently over as short a period as possible. Thus, all surveys were completed between April 30 and May 18, 2001. All sampled hospitals made their managers and staffing records available on the survey date. The ten hospitals operated by the California Department of Developmental Services, Department of Corrections, Department of Mental Health, and Department of Veterans Services were surveyed, using the same procedures and tools, between August 20 and August 31, 2001. We analyzed the data from these State hospitals separately from the data from general acute care (GAC) hospitals.

.4.1 Dataset Construction and Management

Following the completion of data collection, DHS L&C project staff reviewed all survey forms to ensure that the data were legible, and corrected missing or untenable values. Following this initial data preparation, the survey forms were delivered to UC Davis for scanning, data cleaning, and conversion into analytic datasets.

DHS L&C staff scanned the survey forms into TELE*form*™ Version 6.1/6.2 data collection software. TELE*form* was used to process the study forms electronically, using a character recognition engine to identify readable entries and manual verification to correct unreadable entries. First, the paper forms were converted to a TIFF image, then were exported to TELE*form*'s neural character recognition engine for interpretation and validation. This engine evaluated and identified each character and marked field on the image and displayed it onscreen for manual visual validation by a staff operator. The sensitivity of this process was set using customized field confidence settings, which were established at 82% for this project. This setting determined the level of uncertainty associated with identifying each character. At this setting, entries that registered a confidence interval of 82% to 100% displayed automatically, whereas characters that registered between 10% and 81% prompted the operator to manually verify or correct a "best guess" entry, and those that registered less than 10% prompted the operator to enter the data manually. Free text entry fields were set for continuous review. All comment sections were excluded from scanned entry, due to time constraints. All validated data were archived as CSV files.

After the study forms were evaluated and corrected during the scanning and verification process, the TELE*form* CSV data files were exported to SAS® Version 8.0 statistical software, using STAT Transfer® Version 6.0. Two SAS® datasets were created: the first dataset represented survey questions 1 through 18, whereas the second represented questions 19 – 21. A programmer thoroughly cleaned these datasets, following guidelines for reasonable value ranges established by DHS L&C project staff. All missing values and outliers were manually checked against the original paper forms. Following this data cleaning, a quality assurance test of one unit type, Subacute Care, yielded an overall accuracy of 99.0%. This level of accuracy was acceptable for the types of analysis conducted for this report. These SAS files were then converted to STATA® Version 7.0 files for statistical analyses. Raw output was generated in text files, converted to Microsoft™ Excel 2000 spreadsheets for further analysis, and displayed using Microsoft™ Word 2000 tables.

Analysis

.1.1 Staffing Measures

To estimate patient-to-nurse ratios for each sampled shift on each sampled unit, we divided the number of patients actually assigned to beds, gurneys, or bassinets at the beginning of that shift by the number of staff on duty at the beginning of that shift. Staff were aggregated into three categories: registered nurses (RNs), licensed vocational or practical nurses (LVNs/PTs), and unlicensed assistants. Licensed nurses were defined as RNs, LVNs, and PTs. Unlicensed assistants were defined as clerks or secretaries, certified nursing assistants (CNAs), orderlies, orthopedic technicians, telemetry monitoring technicians, and volunteers.

In exploratory analyses, we also estimated patient-to-nurse ratios for each unit based on the "usual patient census for this shift" and the number of "RNs, LVNs, and PTs (usually) scheduled at the beginning of this shift." This measure proved not to be useful, because it was only available for the current shift, precluded separation of RNs from

other licensed staff, and was subject to variability in interpretation across surveyors (i.e., whether the "usual patient census" is instantaneous or cumulative). Similarly, data on cumulative patient care activity (admissions and discharges) over 24 hours could not be used to estimate patient-to-nurse ratios at specific times. Although we collected data on the number of patients assigned to each individual nurse on the current shift, we could not obtain such detailed data from prior shifts, nor did we track overlapping patient assignments (i.e., when an RN and an LVN are assigned to care for the same patient). For this reason, our estimates are based on average staffing at the unit level, rather than at the individual nurse level.

Surveyors only collected data on the **current** shift for emergency departments, postanesthesia care units, and labor and delivery units, because the patient census for these types of units varies from hour to hour, and is not recorded in a consistent manner. These units generally do not maintain staffing logs that could be used to determine the patient-to-nurse ratio at specific times in the past. As a result, all estimates for these units are based on just one surveyed shift at each hospital. Unfortunately, these surveyed shifts were not representative of the entire calendar year, and the original study design did not include repeated resampling of the same units over time. As shown below, nearly all of the surveyed shifts were day shifts, so we have very little data on nurse staffing for evening and night shifts in emergency departments, labor and delivery units, and postanesthesia units.

.2.1 Number of Shifts by Shift Type and Duration

.2.1.1.1

	Number of Shifts			
.1.1 Survey Unit Type	L&D	Emergency	Postanesthesia	**Total**
Day 8 Hr	26	26	52	**96**
Evening 8 Hr	0	2	1	**3**
Day 12 Hr	20	39	4	**63**
Night 12 Hr	0	1	1	**2**
Other (i.e., 10 or 8/12 mixed)	0	3	14	**17**
Total	**40**	**71**	**72**	**183**

We dealt with this problem through linear extrapolation of nursing deficits from the surveyed shift to other shifts on the same day. For emergency departments and labor and delivery units, we tripled the nursing hour shortage from an 8-hour shift, and doubled the shortage from a 12-hour shift, to estimate the shortage for the entire day. In fact, nursing deficits during evening and night shifts might be substantially greater or smaller than nursing deficits during day shifts. For postanesthesia units, we avoided extrapolation by assuming that such units only operate for one shift each day. If some units are open for two or three shifts per day, the actual impact of AB 394 regulations on the demand for postanesthesia nurses may exceed our estimates.

Finally, our estimates for emergency departments (EDs) are further compromised by the fact that seven hospitals had multiple emergency units, only one of which was

randomly sampled. Two of these hospitals had emergency units that were actually in different geographic locations, but which presumably saw similar patients using similar nurse staffing. One hospital had two emergency units in the same location, which were apparently split for administrative convenience. For the other four hospitals, however, multiple emergency units saw fundamentally different patients (e.g., adult versus pediatric, urgent versus emergent) and therefore presumably differed in nurse staffing. Extrapolating from the one surveyed unit within each of these seven EDs to the entire ED was a source of uncertainty in our impact estimates.

Because of the complex stratified sampling scheme, weighted data are presented throughout this report, unless otherwise noted. Each hospital was weighted by the inverse of its probability of being included in the sample. Within a hospital, each unit of a specific type was weighted by the inverse of its sampling probability, which equaled the number of units of that type enumerated by the hospital administrator. Unit-specific weights and hospital-specific weights were multiplied as appropriate. For example, a weight of 5 would have been applied to a medical unit at a county hospital that had a 40% probability of being sampled and two medical units. In other words, that sampled medical unit represents 5 similar units at county hospitals statewide.

.2.1 Nursing FTE Impact

Estimating nursing deficits and financial impacts over a calendar year also required extrapolation from the surveyed shifts and days to the entire year. For each shift, the required number of nurses was estimated by dividing the number of patients reported at the beginning of the shift by each proposed patient-to-nurse ratio. Fractional numbers of nurses (e.g., 11 patients with an AB394 standard of 2 patients per nurse yields 5.5 required nurses) were rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this required number exceeded the actual number of nurses on that shift (e.g. 4), then the whole number shortage was estimated by subtraction (6-4 = 2). We multiplied this integer by the shift length (in hours) to estimate the number of additional nursing hours needed for that shift (e.g., 2 x 8 = 16 hour deficit). The resulting deficits were added across all shifts on each surveyed day, and then extrapolated based on day of week (i.e., 2 Mondays, 3 Thursdays) from the 17 or 18 surveyed days to all 365 days. Seasonal variation was not considered.

We estimated 90% confidence intervals for all nursing deficit estimates using the procedures available in STATA for analyzing complex stratified probability samples. These confidence intervals were truncated at zero, as appropriate. Because these confidence intervals were relatively wide, we rounded all nursing deficit estimates greater than 10 to the nearest 10. Rounding was performed only after any necessary arithmetic manipulations, to avoid rounding error. The confidence intervals shown in this report reflect the fact that we seek to generalize findings from a set of 80 sampled hospitals to all nonfederal acute care hospitals statewide. Confidence intervals could not be estimated for State-operated hospitals, because all of these hospitals were surveyed. The absence of confidence intervals does not imply certainty about the number of additional nurses that State-operated hospitals will need to hire, because we only collected nurse staffing and patient census data for 17 or 18 of 365 days. These days were chosen to be *representative* of all days, and not as a *random* sample. If these days were not actually representative (e.g., because of temporal cycles in the incidence of infectious diseases), then we may have overestimated or underestimated nursing FTE deficits and financial impacts. This type of error is systematic rather than random, so it cannot be described with confidence intervals.

Finally, the annual nursing hour deficit for each unit, within each hospital, was divided by 1700 to estimate the number of nursing FTEs that would have to be hired by that hospital to staff that unit in full compliance with the AB394 proposal. In accord with previous research (Seago 2001, [2]), we assumed that a full-time nurse would provide an average of 1700 hours of productive work per year, excluding vacation time, sick leave, other leave, training and education, and other nonclinical activities. We treated meal and bathroom/coffee breaks as productive work hours for the purposes of the study.

In summary, the impact estimates shown in this report are potentially subject to two forms of uncertainty. The first form of uncertainty derives from so-called "random error," which follows directly from the sampling design. Given enough time and resources, we could have obtained a complete census of California hospitals, nursing units within those hospitals, months of the year, days of the week, and hours of the day. Instead, we collected data from a *sample* of hospitals, units, months, days and hours. We did what we could to minimize random error by using archived logs to ascertain nurse staffing levels on at least 17 different days. Nevertheless, as indicated by the confidence intervals, substantial "random" uncertainty remains, especially for small subgroups.

The other form of uncertainty potentially affecting the impact estimates contained in this report derives from so-called "systematic error" or "bias." In other words, our estimates of AB 394-related nurse FTE requirements and costs may be too high or too low. We believe that the magnitude of any bias is smaller than it would have been if this survey had not been conducted. However, we cannot eliminate all bias, nor can we be certain that the magnitude of bias is small. We *can* describe the most likely sources and direction of any potential bias. In so doing, we alert policymakers to important sources of residual uncertainty and suggest areas for further research and evaluation.

The major sources of potential bias are as follows:

- *Transfer of nurses from one unit to another.* Our analysis assumes that hospitals will not use an apparent nursing surplus on one unit to make up an apparent

deficit on another unit (during the same shift). Although it is plausible that hospitals may transfer staff across units **of the same type** to bring all such units into compliance with AB394, we only collected information on one, randomly selected unit of each type. Therefore, the survey data cannot be used to estimate the impact of nursing transfers across units **of the same type**. Transfers of nursing staff across units **of different types**, during the same shift, could be postulated using the survey data, but were felt to be generally infeasible. Many units require specialized nursing skills (e.g., pediatric, oncology, obstetric, psychiatric) or have patient acuity needs that would make it difficult for hospitals to transfer staff from units with staffing levels that exceed the proposed regulations to units with lower staffing levels. In other words, we assume that current nurse staffing levels reflect market equilibrium, influenced by patient acuity, which would resist perturbation. Relaxing this assumption would reduce the estimated need for new nurses.

- *Sharing of nurses across units on the same shift*. The same nurse cannot work on multiple hospital units at the same time, which precludes sharing of nurses across units on the same shift. Relaxing this assumption would reduce the estimated need for new nurses. In exploratory analyses, estimating and adding fractional deficits (e.g., 0.3 nurses on one shift plus 0.5 nurses on the next shift) resulted in total FTE deficit estimates that were between 11% (combined postpartum/labor and delivery units) and 39% (combined medical/surgical units) lower than the corresponding estimates based on the assumption that nurses are indivisible across units.

- *Static vs. dynamic nurse staffing*. Nurse staffing needs are not necessarily constant across a shift but may change as a result of new admissions and discharges, changes in acuity, and other factors. We ascertained patient-to-nurse staffing ratios at the beginning of each shift, based on the number of nursing staff and the number of patients present on a nursing unit at that time. Any patient admissions or discharges were picked up in the data collected at the beginning of the succeeding shift. We collected no data to describe changes in nursing staff availability and patient census that occur during a single shift. Revising this assumption to reflect the dynamics of nurse staffing and patient load throughout a shift would increase the estimated need for new nurses.

- *Aggregate vs. individual nurse:patient ratios*. A nursing unit that is staffed at a level of x nurses to y patients (aggregate nurse:patient ratio, x:y) may have some individual nurses who are caring for more (or fewer) than y/x patients. Due to data limitations (lack of archived records detailing the number of patients assigned to each individual nurse), we could not estimate the impact of AB394 regulations as applied at the individual nurse level. If nurse managers equalize the distribution of patients among the nurses under their supervision, then the aggregate patient-to-nurse ratio for the unit after implementation of AB 394 will approximately equal the number of patients assigned to each individual nurse. Variation in patient acuity might mean that equalizing assignments would **not** bring the unit into compliance – a

possibility that we could not model. Relaxing this assumption to reflect variation in patient acuity, and associated variation in the number of assigned patients, across nurses on a unit would increase the estimated need for new nurses.

- *Source of newly required nursing hours*. We assumed that the nursing hours needed to comply with the proposed regulations will be worked by nurses hired in response to the new regulations. We did not assume that the extra hours needed would be met by current employees working overtime. Relaxing this assumption would decrease the estimated need for new nurses, but would probably increase the estimated financial impact (assuming that overtime is paid at a higher hourly rate than scheduled work time).

Financial Impact

To estimate financial impacts, we multiplied our estimated FTE deficits by **total** annual paid hours for a full-time nurse (2000), and by weighted averages of RN and LVN hourly wages based on skill mix data from the 6/30/98-6/29/99 OSHPD Hospital Annual Disclosure report. Hourly wages were based on the sum of: (1) the 2000 National Compensation Survey of mean hourly earnings (salary only) by randomly sampled nurses in six metropolitan areas in California (Los Angeles-Riverside-Orange, Sacramento-Yolo, Salinas, San Diego, San Francisco-Oakland-San Jose, Visalia-Tulare-Porterville), weighted in accord with the total employed population in these areas; and (2) the March 2001 survey of Employer Costs for Employee Compensation among civilian workers nationwide (fringe benefits only). We generated separate estimates for RNs and LVNs/PTs, and then weighted these two estimates based on the average skill mix (%RN) among all units of the same type in 1998-99.

This procedure resulted in the following estimates for hourly nursing labor costs: $33.28 for medical, surgical, combined medical/surgical units, mixed and oncology units, $34.39 for pediatric units, $33.95 for stepdown, telemetry, and combined stepdown/ telemetry units, $29.33 for subacute units, $35.01 for labor and delivery units, $34.22 for postpartum and combined labor and delivery/postpartum units, $35.10 for emergency and postanesthesia units, and $32.66 for psychiatric units within acute care hospitals.

As with the FTE estimates, our estimates of the financial impact of AB394 are subject to both random and systematic sources of uncertainty. Random uncertainty is captured in the reported confidence intervals. Systematic uncertainty (potential bias) cannot be quantitated so cleanly but can be described in terms of source and likely direction. In this section, we enumerate potential sources of bias threatening our results and discuss their likely impact.

- *Representativeness of nursing wages in the six selected metropolitan areas*. If the nursing wages in the six metropolitan areas listed above do not represent the entire state, our financial impact estimates may be too high or too low.

- *Fringe benefit costs for nurses in California.* We assumed that these costs equal the national average. If, as recent data suggest, employer premiums for health

insurance coverage are lower in California than in most other states, then we may have slightly overestimated the financial impact of the proposed regulations.

- *Changes in skill mix*. We assumed that hospitals will make up any deficit in licensed nurses pursuant to AB 394 by maintaining the same average skill mix (i.e., RN hours as a percentage of total licensed nurse hours) that they used in 1998-1999. If hospitals choose to minimize their costs by increasing the proportion of LVNs on their nursing staffs, then we may have overestimated the financial impact of the proposed regulations. If, on the other hand, hospitals choose to increase the proportion of their RN staff and decrease the proportion of their LVN staff, then we may have underestimated the financial impact of the proposed regulations.

- *Stability of average nurse salaries*. We assumed that average nursing salaries in California have not changed since the National Compensation Surveys described above (i.e., December 1999 through March 2001). If average nursing salaries have actually increased since that time, then we may have underestimated the financial impact of the proposed regulations.

- *Wage rates for hospital nurses.* We used average nursing wages for nurses practicing in all settings, not just hospitals. If hospital nurses are actually compensated at a higher average level than licensed nurses in other settings, then we may have underestimated the financial impact of the proposed regulations.

- *Costs of hiring/training additional nurses mandated by AB 394.* We used average nursing costs, not marginal costs, because only average costs were available. In so doing, we knowingly, but necessarily violated the microeconomic principle that marginal costs exceed average costs in a competitive market. The extent to which hospitals currently use registry personnel and overtime to staff their units, and the extent to which they may do so after the proposed regulations go into effect, is not known and, therefore, could not be factored into our estimate of financial impact. Likewise, any future potential increase in nursing productivity, reflected in reduced absenteeism and sick leave, cannot be projected and also was not factored into our economic impact estimate. As a result, we may have underestimated the short-term, and overestimated the long-term, financial impact of the proposed regulations.

- *Effect of AB 394 on nurse wages*. For purposes of the fiscal deficit estimate, we assumed that AB394 would have no effect on nursing wages in California. If there is a nursing shortage in California, then prevailing wages are likely to increase as hospitals compete for a limited pool of available nurses. If, however, there is a substantial pool of nurses who have temporarily left the hospital labor market and are prepared to return to hospitals if working conditions improve, then prevailing wages may re-equilibrate at or near the current level. As a result, we may have underestimated the short-term, and overestimated the long-term, financial impact of the proposed regulations.

- *Effect of AB 394 on other nursing-related costs.* We ignore all transaction costs associated with recruiting, interviewing, hiring, training, supervising, and managing these additional nurses. Although these human resource management costs could be significant in the short term, they may diminish in the long term if nursing turnover drops. One empirical study (see Section I, Table 15) found that 10% fewer beds per RN were associated with a 2.5% decrease in resignations per unit per quarter.

Results

.1.1.1.1.1 The Hospitals Surveyed

Eighty hospitals were surveyed, including all 10 University of California teaching hospitals, 10 Kaiser hospitals, 20 rural hospitals, 10 public (city or county) hospitals, and 30 other private hospitals. (Note that our oversampling of the first four types of hospitals was corrected by weighting.) The surveyed hospitals represent all major metropolitan areas in the State (Table 1).

Not all hospitals had all types of units. Table 3a shows that 39 hospitals had labor and delivery units, 37 had postpartum units, and 13 had combined units. Twenty hospitals had stepdown units, 21 had telemetry units, and 18 had combined units. Only 14 hospitals had medical-only units, 21 had surgical-only units, and 40 had combined units. Most hospitals had emergency departments (71) and postanesthesia units (68), but relatively few had pediatric (31), oncology (13), psychiatric (20), or subacute (8) units. Therefore, our estimates of nurse staffing and nursing deficits for the last four types of units are less reliable than our estimates for other units.

.2.1 Workforce Analysis: Description of Nurse Mix and Qualifications

Information about nurses' education, employment, and experience was only obtained for the current (surveyed) shift, which was a day shift for more than 80% of hospital units. Indeed, 91.7% of all surveyed nurses were working on day shifts. Comparative analyses suggested that evening and night shift nurses differ systematically from day shift nurses. Therefore, to make the results generalizable to an identified population, we have restricted our analyses of nursing workforce characteristics to day shift nurses. Sampling weights, according to hospital stratum and unit type, were used to generalize the results to the entire population of day shift nurses working in these unit types, on the surveyed days, in nonfederal licensed acute care hospitals in California. No imputations for missing data were necessary, due to the extremely high item-response rates, which ranged from 96.1% to 100% for all licensed nurses. The day shift dataset consisted of 2,298 nurses from 80 hospitals, of whom 2,092 (91.1%) were RNs, 192 (8.4%) were LVNs, 12 (0.5%) were PTs, and 2 had missing title information.

Education information was only collected on RNs in the survey, because LVNs and PTs can be certified and licensed without having received a specific degree. The majority of RNs working on day shifts have either an AA (43%) or BSN (39%) degree, with very few categorized as "Diploma RN" (15%) or "MSN/DNSc/ND" (2%). Across different types of units, 25% to 69% of RNs have an AA degree. More than 40% of RNs have AA degrees in all unit types

except telemetry (39%), combined medical/surgical (37%), oncology (38%), psychiatric (25%), subacute (29%), and postanesthesia (36%). Medical and pediatric units have the highest percentage of AA degree RNs, at 69% and 64% respectively. Similarly, 23% to 49% of day shift RNs have BSN degrees, with stepdown (49%) and subacute (47%) units at the upper end, and combined postpartum/labor and delivery (29%), medical (23%), pediatric (30%), and psychiatric (26%) units at the lower end of this range. Psychiatric units have the highest percentage of RNs from a diploma nursing program (36%) and the highest percentage of MSN/DNSc/ND nurses (13%).

In terms of employment status, 54% of day shift nurses are employed full-time, 30% are employed part-time, 12% are employed per diem, and 4% are registry (Table 2b). Among day shift RNs (Table 2c), 53% are employed full-time, 30% are employed part-time, 13% are employed per diem, and 4% are registry. Across different types of units, the percentage of RNs who are employed full-time ranges from 36% to 76%, while the percentage of part-time RNs ranges from 14% to 43%, the percentage of per diem RNs ranges from 1% to 19%, and the percentage of registry RNs ranges from 0% to 13%. In stepdown, medical, surgical, pediatric, oncology, subacute, and mixed units, more than 60% of RNs are employed full-time. Combined medical/surgical units have the highest percentage of part-time RNs (43%) while stepdown units have the lowest percentage (14%). Postpartum and emergency units have the highest percentage of per diem RNs (19%), while stepdown units have the lowest percentage (1%). Psychiatric units rely most heavily on registry RNs (13%) whereas subacute units have no registry RNs. Among day shift LVNs and PTs, 63% are employed full-time, 27% are employed part-time, 5% are per diem, and 4% are registry. Because relatively few LVN/PT nurses were surveyed, we could only estimate statewide workforce characteristics for the nine unit types with at least 10 nurses who responded to the employment status question. The percentage of LVN/PT nurses who are employed full-time ranges from 38% to 79% across these nine unit types, with combined stepdown/telemetry units at the high end and surgical units at the low end. Medical units have the highest percentage of part-time LVNs and PTs (49%), while combined stepdown/telemetry units have the lowest percentage (5%). Combined stepdown/telemetry units rely most heavily on per diem LVNs and PTs (16%), whereas combined medical-surgical and subacute units have no per diem LVNs and PTs.

The mean length of experience for all licensed day shift nurses is 15.6 years. The 10^{th} percentile is 3 years, the 25^{th} percentile is 7 years, the median is 14 years, the 75^{th} percentile is 23 years, and the 90^{th} percentile is 30 years. Among day shift RNs (Table

2d), the mean length of experience is 16 years, with a range from 7 to 21.7 years across unit types. The median is 15 years, ranging from 8 to 23 years across unit types. Among day shift LVNs and PTs (Table 2e), the mean length of experience is 11.7 years, with a range from 8.2 to 13.4 years across the 9 unit types with at least 10 nurses who responded to this question. The median is 10 years, ranging from 7 to 15 years across the 9 unit types. Registered nurses in labor and delivery, postpartum, combined post-partum/labor and delivery, psychiatric, and postanesthesia units have the most experience on average (≥17 years), while RNs in combined stepdown/telemetry and subacute units have the least experience on average (<12 years). Postpartum, medical, and surgical units have LVNs and PTs with the most experience on average (>14 years), while combined medical/surgical and subacute units have LVNs and PTs with the least experience on average (<10 years).

.2.1.1.1.1 Staffing Ratios

Table 3a shows the distribution of the number of patients per licensed nurse for each unit type, weighted to represent the statewide distribution among general acute care hospitals. Because the estimates for labor and delivery units, EDs, and postanesthesia units are based on only one shift per hospital, they are less reliable than the estimates for other unit types. The median number of patients per nurse at the beginning of each shift was 5.1 for postpartum units, 2.2 for combined postpartum/labor and delivery units, 2.8 for stepdown units, 4.5 for telemetry units, 3.4 for combined stepdown/telemetry units, 5 for medical units, 4.6 for surgical units, 5.1 for combined medical/surgical units, 3.4 for pediatric units, 4.5 for oncology units, 4.5 for psychiatric units, 7.2 for subacute units, and 5.0 for mixed units.

Table 3b shows how the number of patients per licensed nurse varies across shifts. In general, day and evening shifts have somewhat more generous staffing than night shifts. For example, the median number of patients per nurse on a combined medical/ surgical unit was 4.5 at the beginning of day shift, 4.8 at the beginning of evening shift, and 6.0 at the beginning of night shift. The median number of patients per nurse on a mixed unit was 4.4 at the beginning of day shift, 4.8 at the beginning of evening shift, and 5.5 at the beginning of night shift. Staffing was more uniform across shifts (range <0.8 patients per nurse) for postpartum, stepdown, and combined stepdown/telemetry units. Variability in staffing across shifts potentially increases the financial impact of

AB394 if the same standards are applied to all shifts. This variability is reflected in our impact estimates.

Table 3c further stratifies the number of patients per licensed nurse by shift duration, in addition to time of day. The lowest staffing levels were found on 8-hour night shifts. For example, the median number of patients per nurse on subacute units was 5.5 to 7.2 on day, evening, and swing shifts, but rose to 11.0 on 8-hour night shifts. Similar, but less notable, understaffing of 8-hour night shifts (relative to day and evening shifts) was observed for combined medical/surgical units, psychiatric units, and oncology units.

Table 3d represents a series of five tables showing how the number of patients per licensed nurse varies across hospital strata. Because each stratum includes as few as ten hospitals, we only present quartiles, without shift-stratified estimates. Rural hospitals rely heavily on mixed units, and generally staff these units at a higher level than comparable units elsewhere (i.e., a median of 3.3 patients per nurse versus 4.1 at academic medical centers, 5.7 at Kaiser hospitals, 6.0 at public hospitals, and 5.0 at other private hospitals). Academic medical centers tended to staff at a higher level than other hospitals; for example, we found a median of 4.4 patients per nurse on combined medical/surgical units versus 5.5 at Kaiser hospitals, 4.9 at public hospitals, and 5.0 at other private hospitals. With these exceptions, the similarities in nurse staffing across hospital types were more striking than the differences.

Table 3e shows the distribution of the number of patients per licensed nurse for each unit type, across the ten State-operated hospitals. Because of the small number of State-operated hospitals, we present only the median and range for each unit type. With one exception, State-operated hospitals were staffed at a level very similar to general acute care hospitals.

.2.1.1.1.2 Estimated FTE Deficits

Estimated nursing FTE deficits for general acute care hospitals are presented in Tables 4a, 4b, and 4c. These tables represent three different scenarios for how hospitals might respond to AB394 standards. Under scenario 1, we assume that nurse-staffing regulations would be imposed uniformly on all shifts, and that hospitals would not reassign nurses from shifts staffed above the required level to shifts staffed below that level. In other words, if day shifts are currently staffed at a higher level, and night shifts are staffed at a lower level than the proposed AB394 standard, we assume that hospitals would maintain current day shift staffing and hire additional nurses for night shifts. Such behavior would be expected if current day shift staffing is at an equilibrium level determined by patient acuity and the perceived demand/need for nursing care.

Under scenario 2, we assume that hospitals would reassign nurses from shifts staffed above the required level to shifts staffed below that level **on the same day**. In other words, if day shifts are currently staffed at a higher level, and night shifts are staffed at a lower level than the proposed AB394 standard, we assume that hospitals would transfer nurses from day shift to night shift. Of course, the extent of such redistribution may be limited by patient acuity needs, as estimated by the hospital's Patient Classification System. In addition, hospitals may incur costs in transferring staff

between shifts, either because of shift differentials in hourly pay or because of attrition of existing staff unwilling to transfer to night shift; these costs could not be estimated.

Under Scenario 3, we assume that hospitals would reassign nurses from **any** shift staffed above the required level to **any other** shift (on the same unit) staffed below that level. In other words, if weekday shifts are currently staffed at a higher level, and weekend shifts are staffed at a lower level than the proposed AB394 standard, we assume that hospitals would transfer nurses from weekday to weekend shifts. This scenario represents the absolute minimum impact of the AB 394 standards, under the assumption that all affected hospitals choose to reallocate their nursing staff in a pure cost-minimizing manner, and are permitted to do so by the hospital's Patient Classification System. However, it seems unlikely that a hospital could adjust its staffing in such a flexible manner over a long period (i.e., 3 to 4.5 months in our study). For example, understaffing in the January influenza season could not plausibly be remedied by forcing full-time nurses to work overtime in January, laying them off in April or May, and then rehiring them to work overtime later in the year. If a hospital relied on registry personnel to achieve such flexibility, it would pay more for the agency's administrative overhead, thereby offsetting the potential savings under scenario 3.

The total nursing FTE deficit under scenario 1 was estimated at 30,000 (90% CI, 25,009-34,984) for the CNA proposal, 18,420 (90% CI, 15,082-21,763) for the SEIU proposal, 610 (90% CI, 3856-840) for the CHA proposal, 4,880 (90% CI, 3,944-5,818) for the first phase of the CDHS proposal, and 7,230 (90% CI, 5,931-8,534) for the second phase of the CDHS proposal. The total deficit under scenario 2 was minimally less for the CNA (29,600) and SEIU (17,900) proposals, because transfers across shifts would not remedy the substantial nurse staffing deficits that would be created by implementing these proposed standards. The total deficit under scenario 2 was somewhat less for both the CHA (290) and CDHS (3,940 in the first phase, 6,240 in the second phase) proposals. If the CDHS draft proposal is implemented, general acute care hospitals operating under scenarios 1 and 2 in California would initially need to hire 690-830 postpartum or labor and delivery nurses, 630-840 stepdown or telemetry nurses, 700-1,030 medical or surgical nurses, about 220 ED nurses, 470-490 pediatric nurses, 70-100 oncology nurses, 280-370 psychiatric nurses, about 270 postanesthesia nurses, and 620-740 nurses for mixed units. In the second phase, they would need to hire 1,360-1,420 *additional* medical or surgical nurses, and 930 – 950 *additional* nurses for mixed units.

Tables 4e, 4f, and 4g show the comparable estimates of nursing FTE deficits for State-operated hospitals. We could not estimate confidence intervals because all State-operated hospitals were surveyed. Although our estimates are still subject to uncertainty because staffing data were only collected for 17-18 days, these days were pre-selected as a representative sample of the survey season rather than a truly random sample, making it impossible to estimate confidence intervals. If the CDHS draft proposal is implemented, State-operated hospitals operating under scenarios 1 and 2 would need to hire 5-6 medical or surgical nurses, 16-19 psychiatric nurses, and 1-6 nurses for mixed units.

.2.1.1.1.3 Estimated Financial Impact

The financial impact of these nursing FTE deficits on general acute care hospitals in California is presented in Tables 5a, 5b, and 5c. Under the most costly scenario (1),

implementation of the CNA proposal would cost hospitals $2.000 billion per year in additional nursing labor costs. Implementation of the SEIU proposal would cost hospitals $1.227 billion per year, whereas the CHA proposal would cost hospitals $41 million per year. We estimated the overall cost of the CDHS proposal to general acute care hospitals as $330 million per year in the first phase, and $487 million per year in the second phase (i.e., a $157 million increase in annual costs over the first phase). Under scenario 2, the financial impact of the CNA, SEIU, CHA, and CDHS proposals would fall to $1.974 billion, $1.192 billion, $19 million, and $267 million ($420 million in the second phase), respectively. All of these estimates were based on 1998-1999 skill mix and 1999-2001 nursing compensation rates, and incorporate all of the assumptions described in the Methods section.

These costs may be partially offset by a number of efficiencies, such as improved patient outcomes. It is exceedingly difficult to estimate the magnitude of this offset. However, two major studies have examined the association between nurse staffing and mean length of stay. Lichtig [3] reported that among 352 acute care hospitals in California in 1992, each additional hour of licensed nursing care per patient day, adjusted for acuity using Nursing Intensity Weights, was associated with a 4.8% decrease in geometric mean length of stay. Among 295 California hospitals in 1994, each additional hour of licensed nursing care per acuity-adjusted patient day was associated with a 5.4% decrease in geometric mean length of stay. Needleman et al.[4], using 1997 data from 11 states, reported an acuity-adjusted decrease in length of stay of 9.4% among medical patients and 1.0% among surgical patients with each additional licensed nurse hour per patient day. Using California data, the effects were similar (9.3% and 2.7%, respectively), but not statistically significant. Based on these two studies, we may expect to see an overall reduction of about 5% in mean length of stay in the acute care setting, due to changes in the process of care with higher nurse staffing.

Sovie and colleagues [5] implied (but did not clearly show) that RN work hours per patient day were uncorrelated with total, regionally-adjusted labor costs per discharge *at academic medical centers*, suggesting that the shorter mean length of stay and other efficiencies (e.g., reduced utilization of unlicensed personnel) may fully offset higher nursing labor costs. However, it is very hazardous to extrapolate findings from cross-sectional data on relatively well-staffed academic centers to an entire state. Hospitals with higher nursing labor costs may have lower non-nursing labor costs in cross-sectional data, but this equilibrium may require several years to achieve. Any offsetting savings from lower non-nursing labor costs are probably modest in the short run, but may be substantial in the long run. Further analyses of this possibility are now underway, integrating data from OSHPD's Annual Hospital Disclosure Report and the DHS L&C Survey.

Discussion

In summary, we collaborated with DHS L&C staff on a survey of a stratified probability sample of 80 general acute care hospitals, and a complete sample of ten State-operated hospitals, in California. This survey provides valuable data about current staffing patterns in California hospitals, because detailed information was collected from all non-critical care units and because 100% of sampled hospitals participated. Our key conclusions are:

1. Acute care hospitals in California have diverse nursing staffs with a variety of educational qualifications, employment statuses, and experience. Most types of units rely about equally upon BSN and AA graduates. Although full-time nurses represent at least half of the staff in most types of units, emergency departments, psychiatric units, and postpartum units rely quite heavily on part-time and per diem nurses. Average experience is very high for RNs in labor and delivery, postpartum, and postanesthesia units. Nurses in subacute, combined stepdown/ telemetry, and oncology units are the least experienced, on average. These data confirm that a substantial percentage of inpatient nurses, outside subacute and specialty units, are likely to retire in the next decade.

2. Acute care hospitals also vary widely in the number of patients per licensed nurse, across most types of units. Staffing levels are relatively homogeneous on labor and delivery (interquartile range, 0.9-1.3) units, whereas they are relatively heterogeneous on postpartum (interquartile range, 4.0-6.4), psychiatric (interquartile range, 3.5-6), subacute (interquartile range, 5.5-10.7), and mixed (interquartile range, 3.7-6) units. Average staffing levels observed in this survey were generally similar to average staffing levels estimated in Section II from OSHPD Hospital Disclosure reports, although staffing for some types of units could not be estimated from OSHPD data. The major exception was subacute units, for which we estimated a median of

5.6 patients per nurse from OSHPD data, but we observed a median of 7.2 patients per nurse in this survey.

3. The nursing FTE deficits estimated from this survey are substantially greater than those estimated in Section II using OSHPD Hospital Disclosure reports. We attribute this difference principally to the fact that the former estimates are based on separate tallies of nursing deficits at the beginning of each shift, whereas the latter estimates are based on average staffing levels (over an entire year) for all units of the same type within a hospital. With variability in nurse staffing across shifts and days, a hospital may be adequately staffed (relative to a proposed standard) on average, but staffed below the required level on up to about half of all shifts. However, even these estimates may be too low if AB 394 standards are applied, as proposed, at the individual nurse level rather than the unit level. Some units that are in overall compliance with the proposed patient-to-nurse ratio are likely to have individual nurses with assignments that exceed the allowed size, due to differences in nursing experience and patient acuity.

4. Specifically, the CNA proposal would require acute care hospitals in California to hire as many as 30,000 additional nurses, if hospitals are not allowed or choose not to redistribute staff who are currently working on shifts that are more generously staffed than the regulations would allow. The CDHS proposal would require acute care hospitals in California to hire approximately 4,880 additional nurses in the first phase, followed by about 2,350 more nurses in the second phase, under the same assumption. We are 90% confident that the number of additional nurses to be hired will not exceed 5,820 in the first phase, or a total of 8,534 by the beginning of the second phase. The cost of hiring these additional nurses will be about $330 million per year in the first phase, and about $487 million per year in the second phase, at 1999-2000 wage and fringe benefit rates.

5. The results of our sensitivity analysis indicate that hospitals may be able to lower the financial impact of the proposed regulations to as little as $214 million per year (in the first phase) by: (a) redistributing nurses from day shifts to night shifts, or (b) redistributing nurses from days that appear to be staffed above the required level to days that appear to be staffed below the required level. Of course, the extent of such redistribution may be limited by patient acuity needs, as estimated by the hospital's Patient Classification System. Hospitals may also employ other cost-saving strategies not evaluable using our data, such as floating nurses more often from better-staffed units to less well staffed units, reducing mean length of stay, and reducing non-nursing personnel costs, such as nursing assistants, technicians, and unit clerks. On the other hand, we were also unable to estimate additional costs that could result from recruiting, hiring, training, and managing more nurses, and from demand-induced increases in nursing wages.

6. Our survey-based estimates of nurse staffing and nursing FTE deficits in labor and delivery units, emergency departments, and postanesthesia units are less reliable than our estimates for other units, and do not provide the optimal information needed to set standards for these units. Additional research would be needed to better understand staffing patterns in these high-turnover units.

. 1 . 1 . 1 . 1 . 1 REFERENCES

1. Spetz J, Seago JA, Coffman J, Rosenhoff, O'Neil E. *Minimum Nurse Staffing Ratios in California Acute Care Hospitals*. Center for the Health Professions, University of California, San Francisco, **2000.**

2. Seago JA, Spetz J, Coffman J, O'Neil E. *Minimum Nurse Staffing Ratios in California Acute Care Hospitals*. Abstract presented at the Academy for Health Services Research and Policy, June **2001**.

3. Lichtig LK, Knauf RA, Milholland DK. Some impacts of nursing on acute care hospital outcomes. *JONA* **1999**;29:25-33. See also related work in American Nurses Association. *Implementing Nursing's Report Card: A Study of RN Staffing, Length of Stay, and Patient Outcomes.* Washington, DC: American Nurses Publishing, **1997**.

4. Needleman J, Buerhaus PI, Mattke S, Stewart M, Zelvinsky K. *Nurse Staffing and Patient Outcomes in Hospitals*. Final Report of US DHHS Health Resources and Services Administration Contract No. 230-99-0021. Feb. **2001**.

5. Sovie MD, Gift A, Jawad AF, Stratton L, Wallace PL, Aiken L. *Hospital Restructuring's Impact on Outcomes. Final Report.* National Institute of Nursing Research, NIH Grant No. R01 NR04285. **2000**.

Table 1. Number of General Acute Care Hospitals Surveyed[5] by Health Services Area

Health Services Area	Number of Hospitals Surveyed
Central	5
East Bay	5
Golden Empire	4
Inland Counties	3
Los Angeles County	17
Mid-Coast	2
Northbay	7
North San Joaquin	4
Northern California	11
Orange County	6
San Diego/Imperial	5
Santa Barbara/ Ventura	1
Santa Clara	4
West Bay	6
TOTAL	**80**

[5] State hospitals and free-standing psychiatric hospitals are excluded.

Table 2a. Weighted RN Education Levels, by Survey Unit Type[6]

Survey Unit Type	Number Of Hospitals	Number Of Nurses[7]	Statewide Weighted Counts (%)[8]			
			Diploma RNs	AAs	BSNs	MSNs/DNScs/ NDs
Labor and Delivery Only	40	239	175 (12%)	642 (44%)	583 (40%)	59 (4%)
Postpartum Only	33	135	99 (10%)	422 (44%)	416 (43%)	15 (2%)
Combined Post-partum/ Labor and Delivery	13	56	69 (17%)	197 (48%)	117 (29%)	12 (3%)
Stepdown Only	20	100	18 (4%)	207 (43%)	237 (50%)	12 (3%)
Telemetry Only	21	116	213 (20%)	414 (39%)	373 (35%)	69 (7%)
Combined Stepdown/ Telemetry	18	101	97 (11%)	421 (46%)	396 (43%)	1 (0%)
Medical Only	12	61	20 (5%)	266 (69%)	87 (23%)	11 (3%)
Surgical Only	21	105	115 (18%)	310 (47%)	226 (35%)	3 (1%)
Combined Medical/Surgical	38	176	354 (16%)	835 (37%)	1015 (45%)	30 (1%)
Emergency	63	315	206 (11%)	924 (48%)	757 (40%)	17 (1%)
Pediatric	30	121	34 (6%)	369 (64%)	172 (30%)	5 (1%)
Oncology	12	84	74 (24%)	116 (38%)	116 (37%)	3 (1%)
Psychiatric (Acute Care Hospitals)	17	52	190 (36%)	132 (25%)	141 (27%)	70 (13%)
Sub-Acute/Transitional	88	15	37 (24%)	45 (29%)	72 (47%)	0 (0%)
Postanesthesia	55	237	317 (21%)	546 (36%)	635 (42%)	21 (1%)
Mixed	43	160	311 (19%)	741 (45%)	560 (34%)	27 (2%)

[6] Only RNs were asked about their education al background, so we have no information on LVN education levels.
[7] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.
[8] A category not given in this table is "Unsure". Therefore, the percentages listed in the table do not necessarily add up to 100%.

Table 2b. Weighted RN Employment Status, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[9]	Statewide Weighted Counts (%)[10]			
			Full-time Nurses	Part-time Nurses	Per Diem Nurses	Registry Nurses
Labor and Delivery Only	39	237	768 (53%)	513 (35%)	145 (10%)	28 (2%)
Postpartum Only	33	137	429 (44%)	332 (34%)	183 (19%)	34 (4%)
Combined Post-partum/ Labor and Delivery	13	57	245 (59%)	129 (31%)	42 (10%)	2 (0.5%)
Stepdown Only	20	99	362 (76%)	68 (14%)	5 (1%)	39 (8%)
Telemetry Only	21	115	621 (58%)	228 (21%)	162 (15%)	69 (6%)
Combined Stepdown/ Telemetry	18	101	433 (48%)	301 (34%)	112 (13%)	51 (6%)
Medical Only	12	61	252 (66%)	73 (19%)	49 (13%)	11 (3%)
Surgical Only	21	105	411 (63%)	199 (31%)	39 (6%)	5 (1%)
Combined Medical/Surgical	38	176	817 (37%)	975 (44%)	314 (14%)	134 (6%)
Emergency	64	314	844 (44 %)	646 (34%)	357 (19%)	62 (3%)
Pediatric	30	122	402 (69%)	139 (24%)	31 (5%)	9 (2%)
Oncology	12	82	192 (67%)	80 (28%)	12 (4%)	2 (1%)
Psychiatric (Acute Care Hospitals)	17	52	284 (54%)	130 (24%)	49 (9%)	71 (13%)
Sub-Acute/Transitional	8	16	107 (65%)	46 (28%)	12 (8%)	0 (0%)

[9] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.
[10] Due to rounding, the percentages listed in the table do not necessarily add up to 100%; they may sum to slightly over or slightly under 100%.

Postanesthesia	55	234	855 (56%)	426 (28%)	221 (15%)	19 (1%)
Mixed	43	160	1100 (67%)	335 (20%)	189 (12%)	15 (1%)

Table 2c. Weighted LVN and LPT Employment Status, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[11]	Statewide Weighted Counts (%)[12]			
			Full-time Nurses	Part-time Nurses	Per Diem Nurses	Registry Nurses
Labor and Delivery Only	5	7	---	---	---	---
Postpartum Only	16	21	85 (50%)	72 (42%)	14 (8%)	0 (0%)
Combined Post-partum/ Labor and Delivery	3	3	---	---	---	---
Stepdown Only	3	5	---	---	---	---
Telemetry Only	4	9	---	---	---	---
Combined Stepdown/ Telemetry	6	10	55 (79%)	3 (5%)	11 (16%)	0 (0%)
Medical Only	5	11	39 (40%)	48 (49%)	11 (11%)	0 (0%)
Surgical Only	12	18	42 (38%)	44 (39%)	3 (3%)	23 (20%)
Combined Medical/Surgical	16	22	198 (60%)	123 (38%)	0 (0%)	8 (2%)
Emergency	16	23	74 (73%)	14 (14%)	11 (11%)	1 (1%)
Pediatric	4	4	---	---	---	---

[11] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.

[12] Due to rounding, the percentages listed in the table do not necessarily add up to 100%; they may sum to slightly over or slightly under 100%. Information is only provided for those units with at least 10 nurses who responded to the question.

Oncology	3	4	---	---	---	---
Psychiatric (Acute Care Hospitals)	9	19	123 (52%)	76 (32%)	11 (5%)	25 (11%)
Sub-Acute/Transitional	6	13	102 (64%)	57 (36%)	0 (0%)	0 (0%)
Postanesthesia	2	1	---	---	---	---
Mixed	22	29	171 (65%)	48 (18%)	23 (9%)	23 (9%)

Table 2d. Weighted All Licensed Nurses Employment Status, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[13]	Statewide Weighted Counts (%)[14]			
			Full-time Nurses	Part-time Nurses	Per Diem Nurses	Registry Nurses
Labor and Delivery Only	39	245	798 (53)%	518 (35%)	156 (10%)	28 (2%)
Postpartum Only	33	158	514 (45%)	404 (35%)	197 (17%)	34 (3%)
Combined Post-partum/ Labor and Delivery	13	60	272 (61%)	129 (29%)	42 (9%)	2 (1%)
Stepdown Only	20	104	420 (79%)	68 (13%)	5 (1%)	39 (7%)
Telemetry Only	21	124	713 (61%)	228 (19%)	162 (14%)	69 (6%)
Combined Stepdown/ Telemetry	18	111	488 (51%)	304 (32%)	124 (13%)	51 (5%)
Medical Only	12	72	291 (60%)	121 (25%)	60 (13%)	11 (2%)
Surgical Only	21	123	453 (59%)	243 (32%)	42 (6%)	28 (4%)
Combined Medical/Surgical	38	198	1015 (40%)	1098 (43%)	314 (12%)	142 (6%)
Emergency	64	337	917 (46%)	660 (33%)	368 (18%)	63 (3%)
Pediatric	30	126	409 (69%)	142 (24%)	31 (5%)	9 (2%)

[13] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.
[14] Due to rounding, the percentages listed in the table do not necessarily add up to 100%; they may sum to slightly over or slightly under 100%.

Oncology	12	86	218 (70%)	80 (26%)	12 (4%)	2 (1%)
Psychiatric (Acute Care Hospitals)	17	71	407 (53%)	205 (27%)	60 (8%)	96 (13%)
Sub-Acute/Transitional	8	29	209 (64%)	103 (32%)	12 (4%)	0 (0%)
Postanesthesia	55	235	857 (56%)	426 (28%)	221 (15%)	19 (1%)
Mixed	43	189	1272 (67%)	382 (20%)	212 (11%)	38 (2%)

Table 2e. Weighted Registered Nurse Experience, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[15]	Statewide Weighted Years of Experience					
			Mean	10%ile	25%ile	Median	75%ile	90%ile
Labor and Delivery Only	40	239	17.8	6	12	16	24	30
Postpartum Only	33	138	17.8	3	9	19	23	32
Combined Post-partum/ Labor and Delivery	13	57	17	8	11	17	22	29
Stepdown Only	20	99	13.3	2	5	10	20	30
Telemetry Only	21	120	12.2	1	5	10	20	26
Combined Stepdown/ Telemetry	18	100	11.1	2	5	9	18	26
Medical Only	12	61	14.2	1	4	11	22	30
Surgical Only	21	105	14.3	1	5	12	21	30
Combined Medical/Surgical	38	174	15.9	2	6	14	25	34
Emergency	63	315	16.5	5	9	16	24	30
Pediatric	30	119	15.1	4	6	17	21	30

[15] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.

Oncology	12	82	12.2	2	5	11	15	30
Psychiatric (Acute Care Hospitals)	17	52	17.9	6	11	15	26	35
Sub-Acute/Transitional	8	16	7	1	2	8	9	13
Postanesthesia	55	237	21.7	7	12	23	30	33
Mixed	43	157	15.9	3	6	15	22	31

Table 2f. Weighted LVN and LPT Experience, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[16]	Statewide Weighted Years of Experience[17]					
			Mean	10%ile	25%ile	Median	75%ile	90%ile
Labor and Delivery Only	5	7	---	---	---	---	---	---
Postpartum Only	16	21	15.4	4	12	15	20	24
Combined Post-partum/ Labor and Delivery	3	3	---	---	---	---	---	---
Stepdown Only	3	5	---	---	---	---	---	---
Telemetry Only	4	8	---	---	---	---	---	---
Combined Stepdown/ Telemetry	6	10	12.2	5	10	11	15	20
Medical Only	5	11	14.5	2	4	11	26	35
Surgical Only	12	17	14.5	1	5	9	23	43
Combined Medical/Surgical	16	22	8.2	2	2	8	13	18
Emergency	16	23	12.6	5	9	11	17	23
Pediatric	4	4	---	---	---	---	---	---
Oncology	3	4	---	---	---	---	---	---
Psychiatric (Acute Care Hospitals)	9	18	13.4	7	8	10	20	25
Sub-Acute/Transitional	6	13	9.4	3	6	7	11	22
Postanesthesia	2	2	---	---	---	---	---	---
Mixed	22	28	12.7	2	4	10	25	28

[16] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.
[17] Information is only provided for those units with at least 10 nurses who responded to the question.

Table 2g. Weighted All Licensed Nurses Experience, by Survey Unit Type

Survey Unit Type	Number Of Hospitals	Number Of Nurses[18]	Statewide Weighted Years of Experience					
			Mean	10%ile	25%ile	Median	75%ile	90%ile
Labor and Delivery Only	40	247	17.5	6	12	16	23	30
Postpartum Only	33	159	17.4	3	10	18	22	30
Combined Post-partum/ Labor and Delivery	13	60	16.6	8	10	17	21	29
Stepdown Only	20	104	12.2	2	4	8	20	30
Telemetry Only	21	128	12.3	1	5	10	20	26
Combined Stepdown/ Telemetry	18	110	11.2	2	5	9	18	24
Medical Only	12	72	14.2	2	4	11	22	30
Surgical Only	21	122	14.3	1	5	11	21	30
Combined Medical/Surgical	38	196	15.0	2	5	12	24	34
Emergency	64	339	16.3	5	9	15	24	30
Pediatric	30	123	15.0	4	6	16	21	29
Oncology	12	86	12.0	2	5	10	15	30
Psychiatric (Acute Care Hospitals)	17	70	16.7	6	10	15	24	35
Sub-Acute/Transitional	8	29	8.2	2	5	7	9	20

[18] This number represents the total number of nurses surveyed at a particular hospital unit type who responded to this question.

Postanesthesia	55	239	21.8	7	13	24	30	33
Mixed	43	185	15.5	3	6	14	22	30

Table 3a. Patients per licensed nurse by survey nursing unit type, weighted estimates[19] for all hospitals and shifts.

.1.1.1.1

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse						
			5%ile	10%ile	25%ile	Median	75%ile	90%ile	95%ile
Labor and Delivery Only	39	39	0.55	0.56	0.86	1	1.33	1.8	2
Postpartum Only	37	1650	2	2.67	4	5.07	6.38	7.67	8.67
Combined Post-partum/ Labor and Delivery	13	499	0.67	1	1.5	2.25	3.17	4	4.5
Stepdown Only	20	780	1.6	2	2.33	2.83	3.4	4	4
Telemetry Only	21	956	2.56	2.83	3.71	4.5	5.6	6.8	8.25
Combined Stepdown/Telemetry	18	793	2	2.5	2.67	3.36	4	4.62	5
Medical Only	14	726	3.17	3.71	4.4	5	5.8	7	8
Surgical Only	21	920	2.44	2.89	3.6	4.57	5.67	7.33	8.5
Combined Medical/Surgical	40	1781	3	3.5	4.3	5.14	6	7.5	8
Emergency	71	71	0	0.33	0.5	1	1.6	2	2.86
Pediatric	31	1320	1	1.5	2.5	3.4	4.5	5.5	6
Oncology	13	550	2.5	2.91	3.75	4.5	5.33	6.2	7.5
Psychiatric (Acute Care Hospitals)	20	979	2	2.5	3.5	4.5	6	11	15
Sub-Acute/Transitional	8	343	3.67	4.4	5.5	7.25	10.75	13.33	15
Postanesthesia	68	68	0	0	0	0.8	1.82	2.5	3.43
Mixed	47	2040	1	1.67	3.67	5	6	7.5	8

[19] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.

Table 3b. Patients per licensed nurse by survey nursing unit type and shift type[20], weighted estimates[21] for all hospitals and shifts

.1.1.1.1.1

Survey Unit Type	Shift Type	Number of Shifts	Patients per Licensed Nurse				
			10%ile	25%ile	Median	75%ile	90%ile
Labor and Delivery Only	Day	39	0.56	0.86	1	1.33	1.8
	Eve	---[22]	---	---	---	---	---
	Night	---[2]	---	---	---	---	---
Post-partum Only	Day	655	2.8	3.8	4.93	6	7.33
	Eve	371	2.5	4	5.56	6.75	7.67
	Night	623	2.5	4	5.2	6.5	8.12
Comb Post-partum/L&D	Day	232	1	1.5	2.2	3.33	4
	Eve	50	1	1	1.6	2.25	2.57
	Night	217	1	1.75	2.5	3.25	4
Stepdown Only	Day	351	1.9	2.29	2.71	3.4	4
	Eve	101	2.25	2.5	3	3.4	4
	Night	328	2	2.4	2.83	3.43	4
Telemetry Only	Day	377	2.75	3.4	4	4.5	6
	Eve	222	3.25	4.25	4.75	5.75	7
	Night	340	2.8	4	5	6	8.25
Comb Stepdown/Telemetry	Day	319	2.33	2.67	3.33	3.75	4.4
	Eve	169	2.5	2.67	3.17	3.5	4
	Night	305	2.5	2.67	3.6	4.56	5
Medical Only	Day	262	3.5	4	4.67	5.14	6
	Eve	217	3.4	4.43	5	5.33	6
	Night	231	4.5	5	5.67	6.67	8
	Day	366	2.5	3.33	4.2	4.83	5.67

[20] Shifts designated as other than day, evening, or night shifts were excluded.
[21] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.
[22] No available data

Survey Unit Type	Shift Type	Number of Shifts	Patients per Licensed Nurse				
			10%ile	25%ile	Median	75%ile	90%ile
Surgical Only	Eve	210	3	3.67	4.75	6	7
	Night	327	3	3.8	5	6.33	8.5

Table 3b. (continued)

Survey Unit Type	Shift Type	Number of Shifts	Patients per Licensed Nurse				
			10%ile	25%ile	Median	75%ile	90%ile
Comb Medical/Surgical	Day	704	3.2	4	4.5	5.33	6.33
	Eve	412	3.67	4.4	4.83	5.67	6.5
	Night	665	4	5.14	6	7.33	8.33
Emergency	Day	65	0.33	0.5	0.89	1.5	2
	Eve	---[2]	---	---	---	---	---
	Night	---[2]	---	---	---	---	---
Pediatric	Day	554	1.5	2.5	3.5	4.5	5.67
	Eve	252	1	2	2.67	3.75	4.33
	Night	514	1.5	2.5	3.5	5	5.5
Oncology	Day	231	2.5	3.29	4	4.33	5
	Eve	99	3.75	4.29	4.71	5.25	5.67
	Night	203	3.17	3.82	5	5.67	6.6
Psychiatric (Acute Care Hospitals)	Day	355	2.5	3.25	4	5.33	6
	Eve	287	2.5	3.33	4	5.67	6
	Night	337	3.33	4	6	12	16
	Day	143	4	5	6.5	10	11.25

[2] No available data

Survey Unit Type	Shift Type	Number of Shifts	Patients per Licensed Nurse				
			10%ile	25%ile	Median	75%ile	90%ile
Sub-Acute/Transitional	Eve	66	4.5	5.75	7.25	10	11.67
	Night	134	5.25	6.67	9	13	15
Post anesthesia	Day	54	0	0	0.33	1	2.25
	Eve	---[2]	---	---	---	---	---
	Night	---[2]	---	---	---	---	---
Mixed	Day	831	1.33	3.43	4.4	5.75	7
	Eve	420	2	4	4.8	6	7
	Night	789	1.5	4	5.5	7	8

Table 3c. Patients per licensed nurse by survey nursing unit type, shift type, and shift duration[23], weighted estimates[24] for all hospitals and shifts

.1.1.1.1.1.1

Survey Unit Type	Shift Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile
Labor and Delivery Only	Day 8 hour	20	20	0.64	0.67	1	1.4	2
	Day 12 hour	19	19	0.56	0.86	1	1.14	1.7
	Eve 8 hour	---[25]	---	---	---	---	---	---
	Night 8 hour	---[3]	---	---	---	---	---	---
	Night 12 hour	---[3]	---	---	---	---	---	---
	Day 8 hour	22	389	2.5	4	5	6.33	7.75
	Day 12 hour	15	266	3	3.67	4.5	5.75	7

[23] Shifts designated as other than day, evening, or night shifts of 8 or 12 hour duration were excluded.
[24] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift
[25] No available data

Survey Unit Type	Shift Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile
Post-partum Only	Eve 8 hour	22	371	2.5	4	5.56	6.75	7.67
	Night 8 hour	24	373	2.5	4	5.33	7	8.29
	Night 12 hour	14	248	3	3.8	5	6	6.67
Comb. L&D/ Postpartum	Day 8 hour	3	53	1	1.2	2	2.22	2.7
	Day 12 hour	10	179	1	1.67	2.67	3.6	4
	Eve 8 hour	3	50	1	1	1.6	2.25	2.57
	Night 8 hour	2	49	0.67	1.33	2	2.57	3
	Night 12 hour	10	168	1.33	2	2.67	3.6	4.17
Stepdown Only	Day 8 hour	6	107	2.45	2.67	3	3.6	4
	Day 12 hour	14	244	1.83	2.25	2.67	3.11	4
	Eve 8 hour	6	101	2.25	2.5	3	3.4	4
	Night 8 hour	6	99	2.5	2.6	3.25	4	4.6
	Night 12 hour	15	229	2	2.4	2.83	3.25	4
Telemetry Only	Day 8 hour	13	233	2.8	3.71	4	4.67	6.6
	Day 12 hour	9	144	2.75	3	3.67	4.33	5
	Eve 8 hour	13	222	3.25	4.25	4.75	5.75	7
	Night 8 hour	12	206	3.5	4.44	5.4	6.75	8.5
	Night 12 hour	8	134	2.6	3.25	4	5.5	6.25

Table 3c. (continued)

.1.1.1.1.1.2

Survey Unit Type	Shift Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile
CombStepdown/Telemetry	Day 8 hour	10	178	2	2.67	3	3.5	3.8
	Day 12 hour	8	141	3	3.38	3.73	4.29	5
	Eve 8 hour	10	169	2.5	2.67	3.17	3.5	4
	Night 8 hour	10	169	2.5	2.67	3.25	4	4.6
	Night 12 hour	8	136	2.5	3.33	4.5	4.67	5.6

Survey Unit Type	Shift Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile
Medical Only	Day 8 hour	13	226	3.5	4.14	4.71	5.14	6
	Day 12 hour	2	36	3.75	4	4.25	6	6.33
	Eve 8 hour	13	217	3.4	4.43	5	5.33	6
	Night 8 hour	12	191	4.57	5	5.67	6.67	8.5
	Night 12 hour	2	33	4.25	4.67	5.33	6	6.33
Surgical Only	Day 8 hour	13	225	2.67	3.6	4.4	5.2	6.6
	Day 12 hour	8	141	2.5	3	3.67	4.33	4.83
	Eve 8 hour	13	210	3	3.67	4.75	6	7
	Night 8 hour	12	192	3.25	4.5	5.67	7.33	9
	Night 12 hour	8	133	3	3.5	4.12	5.15	6
Comb Medical/Surgical	Day 8 hour	25	438	3.43	4	4.6	5.5	6.33
	Day 12 hour	15	266	2.71	3.5	4	5	6
	Eve 8 hour	24	412	3.67	4.4	4.83	5.67	6.5
	Night 8 hour	24	412	4.75	5.4	6	7.5	8.5
	Night 12 hour	15	250	3	3.67	4.5	6	7
Emergency	Day 8 hour	26	26	0.33	0.5	0.86	2	2
	Day 12 hour	39	39	0.33	0.5	0.89	1.5	2.25
	Eve 8 hour	---[3]	---	---	---	---	---	---
	Night 8 hour	---[3]	---	---	---	---	---	---
	Night 12 hour	---[3]	---	---	---	---	---	---

Table 3c. (continued)

.1.1.1.1.1.3

Survey Unit Type	Shift Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile

[3] No available data

Pediatric	Day 8 hour	16	269	1.25	2	3	3.75	4.33
	Day 12 hour	17	285	2	3	4	5	6
	Eve 8 hour	16	252	1	2	2.67	3.75	4.33
	Night 8 hour	14	245	1	2	3	4	4.5
	Night 12 hour	17	269	2	3	4	5	5.5
Oncology	Day 8 hour	6	104	3.4	3.75	4	4.83	5.6
	Day 12 hour	8	127	2.17	2.5	2.92	3.8	4.6
	Eve 8 hour	6	99	3.75	4.29	4.71	5.25	5.67
	Night 8 hour	5	83	4.17	5	5.67	6.25	6.75
	Night 12 hour	8	120	2.6	3.4	4	4.67	5
Psychiatric (Acute Care Hospitals)	Day 8 hour	17	301	2.5	3.25	4.14	5.33	6
	Day 12 hour	3	54	3	3.33	4	4.75	6
	Eve 8 hour	17	287	2.5	3.33	4	5.67	6
	Night 8 hour	17	286	3	4	6	14	17
	Night 12 hour	3	50	3.4	4	5	5.67	7
Sub-Acute/Transitional	Day 8 hour	4	72	3.67	5.25	7	10	11.5
	Day 12 hour	4	71	4.2	4.4	5.5	8.5	10.5
	Eve 8 hour	4	66	4.5	5.75	7.25	10	11.67
	Night 8 hour	4	66	5.5	7	11	14	16.5
	Night 12 hour	4	68	5	5.5	6.67	9	11
Postanaesthesia	Day 8 hour	50	50	0	0	0.33	1	2.25
	Day 12 hour	---[3]	---	---	---	---	---	---
	Eve 8 hour	---[3]	---	---	---	---	---	---
	Night 8 hour	---[3]	---	---	---	---	---	---
	Night 12 hour	---[3]	---	---	---	---	---	---

Table 3c. (continued)

Survey Unit Type	**Shift Type**	**Number of Hospitals**	**Number of Shifts**	Patients per Licensed Nurse				
				10%ile	25%ile	Median	75%ile	90%ile

[3] No available data

Mixed	Day 8 hour	26	444	2	3.6	4.5	5.88	7
	Day 12 hour	22	387	1	3.11	4.25	5.33	6.67
	Eve 8 hour	25	420	2	4	4.8	6	7
	Night 8 hour	25	421	2	4.5	5.75	7.33	8.67
	Night 12 hour	22	367	1	4	5.2	6	7.33

Table 3d*i*. Patients per licensed nurse by sampling stratum "Academic Medical Center" and survey nursing unit type, weighted estimates[26] for all hospitals and shifts**.**

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			25%ile	Median	75%ile
Labor and Delivery Only	---[27]	---	---	---	---
Postpartum Only	7	280	3.33	4	4.62
Combined Post-partum/ Labor and Delivery	2	70	1.5	2.13	2.57
Stepdown Only	7	261	2	2.5	2.89
Telemetry Only	5	208	2.6	3	4
Combined Stepdown/Telemetry	4	138	2.25	2.56	2.89
Medical Only	5	229	3.5	4.6	6
Surgical Only	8	327	3	3.89	4.5
Combined Medical/Surgical	6	227	3.83	4.38	5.14
Emergency	8	8	1.67	2.24	2.25
Pediatric	7	259	3	3.4	4.17
Oncology	8	327	2.83	3.38	4.33
Psychiatric (Acute Care Hospitals)	5	239	3.33	4	5
Sub-Acute/Transitional	1	34	5	6	7.5
Postanesthesia	10	10	0.38	0.5	1.28
Mixed	3	120	3.5	4.14	4.8

[26] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.
[27] No percentiles calculated where there were fewer than 8 shifts.

Table 3d*ii*. Patients per licensed nurse by sampling stratum "Kaiser Hospitals" and survey nursing unit type, weighted estimates[28] for all hospitals and shifts

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			25%ile	Median	75%ile
Labor and Delivery Only	8	8	0.8	1	1.54
Postpartum Only	8	411	5.17	6.29	7.67
Combined Post-partum/ Labor and Delivery	---[29]	---	---	---	---
Stepdown Only	4	205	2.75	3.17	4
Telemetry Only	4	210	3.8	4.5	5.33
Combined Stepdown/Telemetry	3	153	3.33	3.67	4
Medical Only	2	103	4	4.75	5.25
Surgical Only	2	104	4	4.4	5
Combined Medical/Surgical	8	394	4.8	5.5	6.67
Emergency	10	10	0.67	1.56	2.33
Pediatric	6	309	2	3	3.25
Oncology	---[2]	---	---	---	---
Psychiatric (Acute Care Hospitals)	---[2]	---	---	---	---
Sub-Acute/Transitional	---[2]	---	---	---	---
Postanesthesia	10	10	0.14	1	1.75
Mixed	5	259	4.75	5.67	7

[28] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.
[29] No percentiles calculated where there were fewer than 8 shifts.

Table 3d*iii*. Patients per licensed nurse by sampling stratum "Rural (OSHPD 1982)" and survey nursing unit type, weighted estimates[30] for all hospitals and shifts

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			25%ile	Median	75%ile
Labor and Delivery Only	---[31]	---	---	---	---
Postpartum Only	---[2]	---	---	---	---
Combined Post-partum/ Labor and Delivery	4	152	1	1.5	2
Stepdown Only	---[2]	---	---	---	---
Telemetry Only	---[2]	---	---	---	---
Combined Stepdown/Telemetry	---[2]	---	---	---	---
Medical Only	---[2]	---	---	---	---
Surgical Only	---[2]	---	---	---	---
Combined Medical/Surgical	3	119	3	4	5
Emergency	20	20	0.31	0.75	1
Pediatric	---[2]	---	---	---	---
Oncology	---[2]	---	---	---	---
Psychiatric (Acute Care Hospitals)	---[2]	---	---	---	---
Sub-Acute/Transitional	1	35	10	10.5	11.5
Postanesthesia	12	12	0	1	1.17
Mixed	19	753	1.5	3.33	4.67

[30] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.
[31] No percentiles calculated where there were fewer than 8 shifts.

.1.1.1.1.1.1.1 *Table 3d*iv. *Patients per licensed nurse by sampling stratum "Other Public" and survey nursing unit type,*

.1.1.1.1.1.1.2 ***weighted estimates[32] for all hospitals and shifts***

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			25%ile	Median	75%ile
Labor and Delivery Only	8	8	0.42	0.76	1.38
Postpartum Only	7	290	3.5	4.4	5.5
Combined Post-partum/ Labor and Delivery	---[33]	---	---	---	---
Stepdown Only	4	156	2	2.29	3
Telemetry Only	1	35	4.2	4.4	4.8
Combined Stepdown/Telemetry	2	104	2.25	2.5	2.78
Medical Only	3	156	4.43	5	5.5
Surgical Only	3	156	3.8	5	6.5
Combined Medical/Surgical	5	213	4.25	4.86	6.25
Emergency	9	9	1.25	1.5	2.58
Pediatric	6	300	2.25	3	4
Oncology	1	35	4.4	4.8	4.8
Psychiatric (Acute Care Hospitals)	7	345	2.5	3.33	5.67

[32] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.
[33] No percentiles calculated where there were fewer than 8 shifts.

Sub-Acute/Transitional	---[2]	---	---	---	---
Postanesthesia	10	10	0	1.19	2
Mixed	4	224	4.67	6	7.33

Table 3d*v*. Patients per licensed nurse by sampling stratum "Other Private" and survey nursing unit type, weighted estimates[34] for all hospitals and shifts

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			25%ile	Median	75%ile
Labor and Delivery Only	17	17	0.93	1	1.33
Postpartum Only	15	669	4	5	6.33
Combined Post-partum/ Labor and Delivery	7	277	1.67	2.38	3.29
Stepdown Only	5	158	2.43	2.83	3.4
Telemetry Only	11	503	3.75	4.5	5.83
Combined Stepdown/Telemetry	9	398	2.67	3.42	4
Medical Only	5	238	4.5	5	6
Surgical Only	8	333	3.83	4.83	6.33
Combined Medical/Surgical	18	828	4.25	5	6
Emergency	24	24	0.5	0.83	1.5
Pediatric	12	452	2.5	3.67	5
Oncology	4	188	4	4.6	5.5
Psychiatric (Acute Care Hospitals)	8	395	3.67	4.67	6
Sub-Acute/Transitional	6	274	5.38	7.17	10.75
Postanesthesia	26	26	0	0.8	1.82
Mixed	15	684	4	5	6.2

[34] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.

Table 3e. Patients per licensed nurse by survey nursing unit type, weighted estimates[35] for California State hospitals and shifts

Survey Unit Type	Number of Hospitals	Number of Shifts	Patients per Licensed Nurse		
			Median	Min	Max
Medical Only	1	46	7.5	5.0	8.0
Combined Medical/Surgical	1	50	5.6	3.2	7.3
Emergency	4	4	---	---	---
Psychiatric (Acute Care Hospitals)	3	135	6.5	2.2	15.0
Postanesthesia	4	4	---	---	---
Mixed	9	439	3.8	0.4	9.0

[35] These estimates are based on the actual number of licensed nurses, and the actual number of beds or gurneys occupied by patients, at the beginning of the sampled shift.

Table 4a. Estimated total yearly FTE shortage for California general acute care hospitals[36] based on a whole number shortage for each shift, by unit type & proposed standard

SCENARIO 1: Shortages calculated separately for each shift[37]

.1.1.1 Survey Unit Type[38]	Number of FTEs per Year Needed to Meet the Proposed Ratios															
	CNA Proposal				SEIU Proposal				CHA Proposal				CDHS Proposal			
	Ratio	FTEs[39]	.1.1	90%CI	Ratio	FTEs[4]	.2.1	90%CI	Ratio	FTEs[4]	.3.1	90% CI	Ratio	FTEs[4]	.4.1	90%CI
			.5.1 lower	upper	.6.1		.7.1 lower	upper	.8.1		.9.1	upper	.10.1		.11.1 lower	upper
Labor and Delivery Only[40]	1:1	1270	*632*	*1898*	1:2	20	*0*	*44*	1:3	0	*0*	*0*	1:2	**20**	*0*	*44*
Postpartum Only	1:5	1160	*678*	*1643*	1:6	520	*282*	*756*	1:8	110	*54*	*175*	1:6	**520**	*282*	*756*
Comb. Postpartum/L&D	---[41]	---	---	---	---[6]	---	---	---	---[6]	---	---	---	1:3	**290**	*25*	*552*
Stepdown Only	1:3	230	*89*	*375*	1:3	230	*89*	*375*	1:6	20	*2*	*41*	1:4	**50**	*12*	*93*
Telemetry Only	1:3	2790	*1444*	*4144*	1:3	2790	*1444*	*4144*	1:10	10	*0*	*26*	1:5	**500**	*199*	*810*
Comb. Stepdown/Telemetry	1:3[42]	1210	*420*	*1994*	1:3[7]	1210	*420*	*1994*	1:6[7]	20	*6*	*33*	1:4[7]	**290**	*97*	*480*
Medical Only	1:3	1900	*862*	*2946*	1:4	900	*391*	*1403*	1:10	20	*3*	*37*	1:6	**160**	*49*	*267*
													1:5	370	*144*	*588*
Surgical Only	1:3	2020	*1017*	*3016*	1:4	920	*389*	*1453*	1:10	10	*3*	*24*	1:6	**200**	*40*	*363*
													1:5	420	*122*	*710*
Combined Medical/Surgical	1:3	7860	*5215*	*10502*	1:4	3680	*2538*	*4812*	1:10	50	*21*	*73*	1:6	**670**	*447*	*892*
													1:5	1670	*1153*	*2183*
Emergency[5]	1:3	220	*0*	*455*	1:3	220	*0*	*455*	1:6	0	*0*	*0*	1:4	100	*0*	*214*
													1:3	**220**	*0*	*455*
													1:2	840	*177*	*1508*
Pediatric	1:3	1130	*160*	*2096*	1:3	1130	*160*	*2096*	1:6	30	*16*	*44*	1:4	**490**	*0*	*989*
Oncology	1:3[43]	730	*192*	*1258*	---[6]	---	---	---	1:10	1	*0*	*3*	1:5	**100**	*10*	*186*

[36] State hospitals and free-standing psychiatric hospitals are excluded.
[37] Assumes that nurse staffing regulations would be imposed uniformly on all shifts and that hospitals would not reassign nurses from shifts staffed above the required level to shifts staffed below that level.
[38] For AB394 legislative unit and survey unit type crosswalk, see page IV –2.
[39] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.
[40] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[41] No proposal.
[42] Applying the stepdown ratio.
[43] Applying the specialty care ratio.

Psychiatric (GACHs)	1:4	1230	*65*	*2397*	1:3	2260	*461*	*4063*	1:12	120	*0*	*320*	1:6	**370**	*0*	*761*
Sub-Acute/Transitional	1:4	1430	*166*	*2684*	1:5	900	*46*	*1754*	1:12	60	*0*	*146*	---[44]	---	---	---
Post-anesthesia	1:2	270	*57*	*479*	1:2	270	*57*	*479*	1:3	80	*1*	*149*	1:2	**270**	*57*	*479*
Mixed	1:3[45]	6560	*4405*	*8720*	1:4[10]	3380	*2206*	*4561*	1:10[10]	80	*29*	*126*	1:6	**740**	*402*	*1074*
													1:5	1670	*1021*	*2316*
TOTAL		**30000**	***25009***	***34984***		**18420**	***15082***	***21763***		**610**	***385***	***840***		**4880**[11]	***3944***	***5818***

Table 4b. Estimated total yearly FTE shortage for California general acute care hospitals[46] based on a <u>whole number</u> shortage for each shift, by unit type & proposed standard

<u>SCENARIO 2: Shortages calculated separately for each day</u>[47]

Survey	**Number of FTEs per Year Needed to Meet the Proposed Ratios**															
	CNA Proposal				**SEIU Proposal**				**CHA Proposal**				**CDHS Proposal**			
Unit Type[48]	Ratio	FTEs[49]	***.1.1***	***90%CI***	Ratio	FTEs	***.2.1***	***90%CI***	Ratio	FTEs	***.3.1***	***90%CI***	Ratio	FTEs	***.4.1***	***90%CI***
			.5.1	***lower*** *upper*	***.6.1***		***.7.1***	***lower*** *upper*	***.8.1***		***.9.1***	***lower*** *upper*	***.10.1***		***.11.1***	***lower*** *upper*
Labor and Delivery Only[50]	1:1	1270	*632*	*1898*	1:2	20	*0*	*44*	1:3	0	*0*	*0*	1:2	**20**	*0*	*44*
Postpartum Only	1:5	1080	*613*	*1547*	1:6	410	*195*	*632*	1:8	70	*24*	*117*	1:6	**410**	*195*	*632*
Comb. Postpartum/L&D	---[51]	---	---	---	---[6]	---	---	---	---[6]	0	---	---	1:3	**250**	*4*	*505*
Stepdown Only	1:3	220	*81*	*355*	1:3	220	*81*	*355*	1:6	10	*0*	*25*	1:4	**40**	*8*	*79*
Telemetry Only	1:3	2750	*1405*	*4091*	1:3	2750	*1405*	*4091*	1:10	0			1:5	**380**	*92*	*663*
Comb.Stepdown/Telemetry	1:3[52]	1190	*403*	*1968*	1:3[7]	1190	*403*	*1968*	1:6[7]	3	*0*	*7*	1:4[7]	**210**	*65*	*355*
Medical Only	1:3	1890	*851*	*2932*	1:4	870	*373*	*1376*	1:10	9	*0*	*19*	1:6	**100**	*26*	*165*
													1:5	320	*115*	*516*
Surgical Only	1:3	2000	*1002*	*2999*	1:4	890	*362*	*1422*	1:10	4	*0*	*9*	1:6	**150**	*0*	*311*
													1:5	360	*74*	*653*
Combined Medical/Surgical	1:3	7810	*5172*	*10453*	1:4	3540	*2420*	*4649*	1:10	10	*0*	*23*	1:6	**450**	*262*	*637*
													1:5	1380	*902*	*1857*
	1:3	220	*0*	*455*	1:3	220	*0*	*455*	1:6	0	*0*	*0*	1:4	100	*0*	*214*

[44] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.
[45] Applying the Medical/Surgical ratio.
[11] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence intervals for Scenario 1 based on the 1:5 ratios are; Total: 7230, Lower Confidence Interval: 5931, and Upper Confidence Interval: 8534
[46] State hospitals and free-standing psychiatric hospitals are excluded.
[47] Assumes that nurse staffing regulations would be imposed as an average across all shifts on a given day, or that hospitals would reassign nurses from shifts staffed above the required level to shifts staffed below that level on the same day (i.e. day shift to night shift).
[48] For AB394 legislative unit and survey unit type crosswalk, see page IV –2
[49] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.
[50] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[51] No proposal.
[52] Applying the stepdown ratio.

Emergency[5]													1:4 1:2	100 220	0 170	214 1668
Pediatric	1:3	1100	137	2072	1:3	1100	137	2072	1:6	20	7	32	1:4	**470**	0	975
Oncology	1:3[53]	710	176	1235	---[6]	---	---	---	1:10	0	0	0	1:5	**70**	0	138
Psychiatric (GACHs)	1:4	1160	0	2315	1:3	2220	422	4023	1:12	1	0	3	1:6	**280**	0	581
Sub-Acute/Transitional	1:4	1410	154	2670	1:5	890	38	1744	1:12	50	0	117	---[54]	**---**	---	---
Post-anesthesia	1:2	270	57	479	1:2	270	57	479	1:3	80	1	149	1:2	**270**	57	479
Mixed	1:3[55]	6530	4378	8688	1:4[10]	3310	2140	4481	1:10[10]	40	5	77	1:6[10] 1:5	**620** 1570	309 931	930 2201
TOTAL		**29600**	**24606**	**34593**		**17900**	**14555**	**21241**		**290**	**177**	**402**		**3940**[56]	**3067**	**4809**

Table 4c. **Estimated total yearly FTE shortage for California general acute care hospitals**[57] based on a <u>whole number</u> shortage for each shift, by unit type & proposed standard

<u>SCENARIO 3: Shortages calculated and averaged over entire 17-day sampling period</u>[58]

.1.1.1.1 Survey	**Number of FTEs per Year Needed to Meet the Proposed Ratios**															
	CNA Proposal				**SEIU Proposal**				**CHA Proposal**				**CDHS Proposal**			
Unit Type[59]	Ratio	FTEs[60]	***.1.1 90%CI***		Ratio	FTEs	***.2.1 90%CI***		Ratio	FTEs	***.3.1 90%CI***		Ratio	FTEs	***.4.1 90%CI***	
			.5.1 lower	*upper*	***.6.1***		***.7.1 lower***	*upper*	***.8.1***		***.9.1 lower***	*upper*	***.10.1***		***.11.1 lower***	*upper*
Labor and Delivery Only[61]	1:1	1270	632	1898	1:2	20	0	44	1:3	0	0	0	1:2	**20**	0	44
Postpartum Only	1:5	960	503	1415	1:6	330	117	542	1:8	20	0	62	1:6	**330**	117	542
Comb. Postpartum/L&D	---[62]	---	---	---	---[6]	---	---	---	---[6]	---	---	---	1:3	**180**	0	399
Stepdown Only	1:3	170	45	292	1:3	170	45	292	1:6	0	0	0	1:4	**10**	0	27
Telemetry Only	1:3	2730	1389	4062	1:3	2730	1389	4062	1:10	0	0	0	1:5	**270**	0	555
Comb.Stepdown/Telemetry	1:3[63]	1150	369	1923	1:3[7]	1150	369	1923	1:6[7]	0	0	0	1:4[7]	**130**	20	246
Medical Only	1:3	1890	844	2926	1:4	860	361	1354	1:10	0	0	0	1:6 1:5	**40** 280	0 86	95 470
Surgical Only	1:3	2010	1009	3013	1:4	860	323	1391	1:10	0			1:6	**130**	0	292

[53] Applying the specialty care ratio.
[54] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.
[55] Applying the Medical/Surgical ratio.
[56] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence intervals for Scenario 1 based on the 1:5 ratios are; Total: 6240, Lower Confidence Interval: 4962, and Upper Confidence Interval: 7525
[57] State hospitals and free-standing psychiatric hospitals are excluded.
[58] Assumes that hospitals would reassign nurses from any shift staffed above the required level to any other shift staffed below that level (i.e., weekday shifts to weekend shifts, spring shifts to winter shifts).
[59] For AB394 legislative unit and survey unit type crosswalk, see page IV –2
[60] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.
[61] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[62] No proposal.
[63] Applying the stepdown ratio.

											0	0	1:5	310	*24*	*603*
Combined Medical/Surgical	1:3	7850	*5167*	*10524*	1:4	3500	*2363*	*4628*	1:10	0	0	0	1:6	**290**	*122*	*468*
													1:5	1200	*736*	*1667*
Emergency[5]	1:3	220	*0*	*455*	1:3	220	*0*	*455*	1:6	0	0	0	1:4	100	*0*	*214*
													1:3	**220**	*0*	*455*
													1:2	840	*177*	*1508*
Pediatric	1:3	1100	*104*	*2090*	1:3	1100	*104*	*2090*	1:6	7	0	20	1:4	**440**	*0*	*954*
Oncology	1:3[64]	690	*173*	*1212*	---[6]	---	---	---	1:10	0	0	0	1:5	**50**	*0*	*110*
Psychiatric (GACHs)	1:4	1070	*4*	*2145*	1:3	2140	*429*	*3851*	1:12	0	0	1	1:6	**210**	*0*	*450*
Sub-Acute/Transitional	1:4	1390	*132*	*2657*	1:5	860	*7*	*1714*	1:12	50	0	121	---[65]	**---**	---	---
Postanesthesia	1:2	270	*57*	*479*	1:2	270	*57*	*479*	1:3	80	1	149	1:2	**270**	*57*	*479*
Mixed	1:3[66]	6570	*4401*	*8746*	1:4[10]	3300	*2113*	*4481*	1:10[10]	0	0	0	1:6[10]	**550**	*228*	*871*
													1:5	1420	*773*	*2075*
TOTAL		**29330**	***24347***	***34305***		**17480**	***14174***	***20783***		**150**	***43***	***263***		**3150[67]**	***2293***	***4001***

[64] Applying the specialty care ratio.
[65] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.
[66] Applying the Medical/Surgical ratio.
[67] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence interval for Scenario 1 based on the 1:5 ratios are; Total: 5350, Lower Confidence Interval: 4054, and Upper Confidence Interval: 6637

Table 4d. Percentage of hospital unit days (during 17 sampled days) currently not meeting proposed ratios

.1.1.1 Survey Unit Type[68]	Percentage of Hospital Unit Days Short															
	CNA Proposal				SEIU Proposal				CHA Proposal				CDHS Proposal			
	Ratio	Percent	.1.1	90%CI	Ratio	Percent	.2.1	90%CI	Ratio	Percent	.3.1	90% CI	Ratio	Percent	.4.1	90%CI
			.5.1	upper	.6.1		.7.1	upper	.8.1		.9.1	upper	.10.1		.11.1	upper
Labor and Delivery Only	1:1	40	*23*	*56*	1:2	1	*0*	*3*	1:3	0	*0*	*0*	1:2	**1**	*0*	*3*
Postpartum Only	1:5	60	*50*	*72*	1:6	30	*22*	*43*	1:8	8	*4*	*13*	1:6	**30**	*22*	*43*
Comb. Postpartum/L&D	---[69]	---	*---*	*---*	---[6]	---	*---*	*---*	---[6]	---	*---*	*---*	1:3	**30**	*15*	*46*
Stepdown Only	1:3	40	*18*	*58*	1:3	40	*18*	*58*	1:6	2	*0*	*3*	1:4	**7**	*1*	*13*
Telemetry Only	1:3	90	*79*	*99*	1:3	90	*79*	*99*	1:10	0	*0*	*0*	1:5	**35**	*22*	*49*
Comb. Stepdown/Telemetry	1:3[70]	70	*49*	*94*	1:3[3]	70	*49*	*94*	1:6[3]	1	*0*	*2*	1:4[3]	**30**	*13*	*48*
Medical Only	1:3	100	*96*	*100*	1:4	90	*84*	*97*	1:10	2	*0*	*5*	1:6	**30**	*14*	*41*
													1:5	70	*60*	*79*
Surgical Only	1:3	90	*87*	*96*	1:4	70	*57*	*84*	1:10	2	*0*	*4*	1:6	**25**	*12*	*43*
													1:5	45	*30*	*58*
Combined Medical/Surgical	1:3	95	*95*	*100*	1:4	85	*82*	*93*	1:10	1	*0*	*3*	1:6	**30**	*20*	*44*
													1:5	60	*51*	*72*
Emergency	1:3	4	*0*	*8*	1:3	4	*0*	*8*	1:6	0	*0*	*0*	1:3	**4**	*0*	*8*
Pediatric	1:3	65	*48*	*79*	1:3	65	*48*	*79*	1:6	3	*1*	*5*	1:4	**40**	*19*	*62*
Oncology	1:3[71]	90	*84*	*98*	---[2]	0	*0*	*0*	1:10	0	*0*	*0*	1:5	**40**	*18*	*60*

[68] For AB394 legislative unit and survey unit type crosswalk, see page IV –2.
[69] No proposal.
[70] Applying the Stepdown ratio.
[71] Applying the Specialty Care ratio.

Psychiatric (GACHs)	1:4	70	*53*	*89*	1:3	90	*80*	*100*	1:12	0	*0*	*1*	1:6	**40**	*15*	*69*
Sub-Acute/Transitional	1:4	95	*90*	*100*	1:5	85	*73*	*99*	1:12	25	*0*	*59*	---[72]	**0**	*0*	*0*
Post-anesthesia	1:2	15	*5*	*22*	1:2	15	*5*	*22*	1:3	6	*0*	*11*	1:2	**15**	*5*	*22*
Mixed	1:3[73]	85	*72*	*94*	1:4[6]	75	*64*	*87*	1:10[6]	4	*1*	*8*	1:6	**30**	*20*	*43*
													1:5	55	*46*	*68*

[72] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit shall, at a minimum, meet the staffing requirements contained in the sub-acute contracts between the Medi-Cal program and the general acute care hospital.
[73] Applying the Medical/Surgical ratio.

Table 4e. Estimated total yearly FTE shortage for California State hospitals[74] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard
SCENARIO 1: Shortages calculated separately for each shift[75]

Survey Unit Type[76]	Number of Nursing FTEs Needed to Meet the Proposed Ratios							
	CNA Proposal		SEIU Proposal		CHA Proposal		CDHS Draft	
	Ratio	FTEs[77]	Ratio	FTEs	Ratio	FTEs	Ratio	FTEs
.1.1.1.1 Medical Only	1:3	16	1:4	9	1:10	0	1:6	4
							1:5	7
Combined Medical/Surgical	1:3	20	1:4	9	1:10		1:6	2
							1:5	5
Emergency[78]	1:3	0	1:3	0	1:6	0	1:4	0
							1:2	0
Psychiatric (Acute Care Hospitals)	1:4	66	1:3	108	1:12	3	1:6	19

[74] Includes Agnew Hospital, CA Institute For Men, CA Medical Facility, CA Men's Colony, CA State Hospital, Fairview Developmental Center, Lanterman Developmental Center, Porterville Developmental Center, Sonoma Developmental Center, Veteran's Home of CA- Yountville.
[75] Assumes that nurse staffing regulations would be imposed uniformly on all shifts and that hospitals would not reassign nurses from shifts staffed above the required level to shifts staffed below that level.
[76] For AB394 legislative unit and survey unit type crosswalk, see page IV –2.
[77] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.
[78] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.

Postanesthesia	1:2	0	1:2	0	1:3	0	1:2	0
Mixed	1:3[79]	95	1:4[6]	40	1:10[6]	0	1:6[6]	6
							1:5	15
TOTAL		**197**		**166**		**3**		**30[80]**

[79] Applying the Medical/Surgical ratio.
[80] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, andCombined Medical/Surgical, and the 1:4 ratio for Emergency. The total for Scenario 1 based on the 1:5 ratio is 46.

Table 4f. Estimated yearly FTE shortage for California State hospitals[81] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard

SCENARIO 2: Shortages calculated separately for each day[82]

Survey Unit Type[83]	Number of Nursing FTEs Needed to Meet the Proposed Ratios							
	CNA Proposal		SEIU Proposal		CHA Proposal		CDHS Draft	
	Ratio	FTEs[84]	Ratio	FTEs	Ratio	FTEs	Ratio	FTEs
.1.1.1.1 Medical Only	1:3	16	1:4	9	1:10	0	1:6	4
							1:5	7
Combined Medical/Surgical	1:3	20	1:4	9	1:10	0	1:6	1
							1:5	4
Emergency[85]	1:3	0	1:3	0	1:6	0	1:4	0
							1:2	0
Psychiatric (Acute Care Hospitals)	1:4	66	1:3	108	1:12	1	1:6	16
Postanesthesia	1:2	0	1:2	0	1:3	0	1:2	0
Mixed	1:3[86]	94	1:4[6]	38	1:10[6]	0	1:6[6]	1
							1:5	9
TOTAL		**196**		**164**		**1**		**22[87]**

1 Includes Agnew Hospital, CA Institute For Men, CA Medical Facility, CA Men's Colony, CA State Hospital, Fairview Developmental Center, Lanterman Developmental Center, Porterville Developmental Center, Sonoma Developmental Center, Veteran's Home of CA- Yountville.

[82] Assumes that nurse staffing regulations would be imposed as an average across all shifts on a given day, or that hospitals would reassign nurses from shifts staffed above the required level to shifts staffed below that level on the same day (i.e. day shift to night shift).

[83] For AB394 legislative unit and survey unit type crosswalk, see page IV –2.

[84] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.

[85] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.

[86] Applying the Medical/Surgical ratio.

[87] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, andCombined Medical/Surgical, and the 1:4 ratio for Emergency. The total for Scenario 1 based on the 1:5 ratio is 36.

Table 4g. Estimated yearly FTE shortage for California State hospitals[88] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard

SCENARIO 3: Shortages calculated and averaged over entire 17-day sampling period[89]

Survey Unit Type[90]	Number of Nursing FTEs Needed to Meet the Proposed Ratios							
	CNA Proposal		SEIU Proposal		CHA Proposal		CDHS Draft	
	Ratio	FTEs[91]	Ratio	FTEs	Ratio	FTEs	Ratio	FTEs
.1.1.1.1 Medical Only	1:3	6	1:4	3	1:10	0	1:6	1
							1:5	3
Combined Medical/Surgical	1:3	7	1:4	3	1:10	0	1:6	0
							1:5	1
	1:3	0	1:3	0	1:6	0	1:4	0

[88] Includes Agnew Hospital, CA Institute For Men, CA Medical Facility, CA Men's Colony, CA State Hospital, Fairview Developmental Center, Lanterman Developmental Center, Porterville Developmental Center, Sonoma Developmental Center, Veteran's Home of CA- Yountville.

[89] Assumes that hospitals would reassign nurses from any shift staffed above the required level to any other shift staffed below that level (i.e., weekday shifts to weekend shifts, spring shifts to winter shifts).

[90] For AB394 legislative unit and survey unit type crosswalk, see page IV –2.

[91] For each shift, the number of nurses required is estimated by dividing the number of patients reported at the beginning of the shift by each proposed ratio. A "fractional" number of nurses may be calculated (e.g. 11 patients with a standard of 1 nurse: 2 patients gives a required number of 11/2= 5.5 nurses). This fractional number is rounded upward to the next integer, assuming that units cannot share nurses with other units on the same shift. If this number is greater than the actual number of nurses on that shift (e.g. 4), then the whole number shortage is estimated by subtraction (6-4 = 2). This whole number shortage is multiplied by the shift length (in hours) to give the number of additional nursing hours needed for that shift (e.g. 2 x 8 = 16 hours short). The resulting numbers are added across all shifts on each surveyed day and then extrapolated from the 17-18 surveyed days to all 365 days. This number is then rounded to the nearest 10.

Emergency[92]	1:3	0	1:3	0	1:6	0	1:4	0
Psychiatric[92] (Acute Care Hospitals)	1:4	25	1:3	41	1:12	0	1:6	0 6
Postanesthesia	1:2	0	1:2	0	1:3	0	1:2	0
							1:6[6]	0
							1:5	2
TOTAL		**77**		**62**		**0**		**7[94]**

[92] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[93] Applying the Medical/Surgical ratio.
[94] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, andCombined Medical/Surgical, and the 1:4 ratio for Emergency. The total for Scenario 1 based on the 1:5 ratio is 12.

Table 5a. Estimated financial impact of total yearly FTE shortage for California general acute care hospitals[95] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard
SCENARIO 1: Shortages calculated separately for each shift[96]

.1.1.1.1 Survey Unit Type[97]	Personnel Costs per Year Needed to Meet the Proposed Ratios																
	CNA Proposal				SEIU Proposal				CHA Proposal				CDHS Proposal				
	Ratio	.1.1 Deficit[98] ($1000s)	.2.1 90%CI		Ratio	Deficit ($1000s)	.3.1 90%CI		Ratio	.4.1 Deficit ($1000s)	.5.1 90%CI		Ratio	Deficit ($1000s)	.6.1 90%CI	
			.7.1 lower	upper			.8.1 lower	upper			.9.1 lower	upper			.10.1 lower	upper
Labor and Delivery Only[99]	1:1	88,603	*44,277*	*132,928*	1:2	1,155	*0*	*3,077*	1:3	0	*0*	*0*	1:2	**1,155**	*0*	*3,077*
Postpartum Only	1:5	79,434	*46,410*	*112,458*	1:6	35,519	*19,281*	*51,756*	1:8	7,826	*3,702*	*11,950*	1:6	**35,519**	*19,281*	*51,756*
Comb. Postpartum/ L&D	---[100]	---	---	---	---[6]	---	---	*0*	---[6]	---	---	---	1:3	**19,753**	*1,723*	*37,783*
Stepdown Only	1:3	15,763	*6,044*	*25,481*	1:3	15,763	*6,044*	*25,481*	1:6	1,462	*168*	*2,756*	1:4	**3,569**	*814*	*6,324*
Telemetry Only	1:3	189,702	*98,053*	*281,352*	1:3	189,702	*98,053*	*281,352*	1:10	777	*0*	*1,752*	1:5	**34,245**	*13,516*	*54,974*
Comb. Stepdown/Telemetry	1:3[101]	81,970	*28,532*	*135,408*	1:3[7]	81,970	*28,532*	*135,408*	1:6[7]	1,338	*414*	*2,261*	1:4[7]	**19,604**	*6,589*	*32,619*
Medical Only	1:3	126,715	*57,373*	*196,057*	1:4	59,711	*26,011*	*93,411*	1:10	1,337	*195*	*2,478*	1:6	**10,527**	*3,281*	*17,773*
													1:5	24,365	*9,605*	*39,125*
Surgical Only	1:3	134,195	*67,669*	*200,721*	1:4	61,303	*25,905*	*96,700*	1:10	886	*196*	*1,576*	1:6	**13,427**	*2,690*	*24,165*
													1:5	27,683	*8,088*	*47,278*
Comb. Medical/Surgical	1:3	523,059	*347,111*	*699,006*	1:4	244,610	*168,902*	*320,318*	1:10	3,109	*1,371*	*4,847*	1:6	**44,563**	*29.733*	*59.393*
													1:5	111,041	*76,757*	*145,325*
Emergency[5]	1:3	15,350	*0*	*31,920*	1:3	15,350	*0*	*31,920*	1:6	0	*0*	*0*	1:4	6.823	*0*	*15.030*
													1:3	**15,350**	*0*	*31,920*
													1:2	59,144	*12,404*	*105,883*
Pediatric	1:3	77,595	*11,030*	*144,161*	1:3	77,595	*11,030*	*144,161*	1:6	2,051	*1,068*	*3,034*	1:4	**33,406**	*0*	*68,040*
Oncology	1:3[102]	48,265	*12,798*	*83,733*	---[4]	---	---	---	1:10	67	*0*	*169*	1:5	**6,552**	*691*	*12,412*

[95] State hospitals and free-standing psychiatric hospitals are excluded.
[96] Assumes that nurse staffing regulations would be imposed uniformly on all shifts and that hospitals would not reassign nurses from shifts staffed above the required level to shifts staffed below that level.
[97] For AB394 legislative unit and survey unit type crosswalk, see page IV – 2.
[98] Calculated using unrounded estimates. To estimate total deficit dollars, FTEs are multiplied by total yearly paid nursing hours (2000) and by the weighted averages of RN and LVN hourly wages based on the OSHPD data on skill mix: L&D - $35.01, Postpartum, Comb. L&D/PP - $34.22, Med, Surg, combined Med/Surg, Onc., Mixed - $33.28, Emer. , Postanesthesia - $35.10, Pediatric - $34.39, Stepdown, Tele, combined Stepdown/Tele - $33.95, Subacute - $29.33, Psych/GAC - $32.66.
[99] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[100] No proposal.
[101] Applying the Stepdown ratio.

Psychiatric (GACHs)	1:4	80,424	*4,256*	*156,593*	1:3	147,741	*30,108*	*265,373*	1:12	8,077	*0*	*20,931*	1:6	**24,357**	*0*	*49,707*
Sub-Acute/Transitional	1:4	83,595	*9,727*	*157,463*	1:5	52,799	*2,716*	*102,882*	1:12	3,440	*0*	*8,550*	---[103]	---	---	---
Postanesthesia	1:2	18,813	*4,034*	*33,592*	1:2	18,813	*4,034*	*33,592*	1:3	5,272	*57*	*10,488*	1:2	**18,814**	*4,034*	*33,592*
Mixed	1:3[104]	436,806	*293,208*	*580,404*	1:4[10]	255,213	*146,845*	*303,582*	1:10[10]	5,151	*1,931*	*8,372*	1:6[10]	**49.130**	*26.742*	*71.518*
													1:5	111,079	*67,983*	*154,175*
TOTAL		**2,000,290**	*1,667,606*	*2,332,724*		**1,227,243**	*1,004,738*	*1,449,828*		**40,792**	*25,778*	*56,169*		**329,970**[11]	266,699	*393,397*

[102] Applying the Specialty care ratio.
[103] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit, and a Transitional program in a general acute care hospital shall, at a minimum, meet the staffing requirements contained in the Sub-acute and Transitional inpatient care contracts between the Medi-Cal program and the general acute care hospital.
[104] Applying the Medical/Surgical ratio.
[11] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence intervals for Scenario 1 based on the 1:5 ratios are ($1000s); Total: 486,490, Lower Confidence Interval: 401,045, and Upper Confidence Interval: 577,076.

Table 5b. Estimated financial impact of total yearly FTE shortage for California general acute care hospitals[105] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard
SCENARIO 2: Shortages calculated separately for each day [106]

Survey[107] Unit Type	Personnel Costs per Year Needed to Meet the Proposed Ratios														
	CNA Proposal				SEIU Proposal				CHA Proposal				CDHS Proposal		
	Ratio	Deficit[108] ($1000s)	.1.1 90%CI .5.1 lower	upper	Ratio	Deficit ($1000s)	.2.1 90%CI .6.1 lower	upper	Ratio	Deficit ($1000s)	.3.1 90%CI .7.1 lower	upper	Ratio	Deficit ($1000s)	.4.1 90%CI .8.1 lower	upper
Labor and Delivery Only[109]	1:1	88,603	*44,277*	*132,928*	1:2	1,155	*0*	*3,077*	1:3	0	*0*	*0*	1:2	**1,155**	*0*	*3,077*
Postpartum Only	1:5	73,927	*41,970*	*105,884*	1:6	28,307	*13,375*	*43,238*	1:8	4,850	*1,667*	*8,033*	1:6	**28,307**	*13,375*	*43,238*
Comb. Postpartum/ L&D	---[110]	---	---	---	---[6]	---	---	---	---[6]	---	---	---	1:3	**17,441**	*289*	*34,592*
Step-down Only	1:3	14,831	*5,530*	*24,132*	1:3	14,831	*5,530*	*24,132*	1:6	782	*0*	*1,677*	1:4	**2,966**	*546*	*5,385*
Telemetry Only	1:3	186,591	*95,395*	*277,787*	1:3	186,591	*95,395*	*277,787*	1:10	0	*0*	*0*	1:5	**25,620**	*6,231*	*45,008*
Comb. Stepdown/Telemetry	1:3[111]	80,489	*27,356*	*133,622*	1:3[7]	80,489	*27,356*	*133,622*	1:6[7]	182	*0*	*458*	1:4[7]	**14,246**	*4,396*	*24,096*
Medical Only	1:3	125,916	*56,660*	*195,173*	1:4	58,206	*24,853*	*91,560*	1:10	549	*0*	*1,247*	1:6	**6,383**	*1,758*	*11,009*
													1:5	21,014	*7,675*	*34,354*
Surgical Only	1:3	133,169	*66,705*	*199,634*	1:4	59,364	*24,095*	*94,632*	1:10	247	*0*	*568*	1:6	**10,228**	*0*	*20,671*
													1:5	24,201	*4,947*	*43,454*
Combined Medical/Surgical	1:3	519,996	*344,271*	*695,721*	1:4	235,259	*161,059*	*309,459*	1:10	702	*0*	*1,508*	1:6	**29,925**	*17,461*	*42,389*
													1:5	91,832	*60,046*	*123,619*
Emergency[5]	1:3	15,350	*0*	*31,920*	1:3	15,350	*0*	*31,920*	1:6	0	*0*	*0*	1:4	6.823	*0*	*15.030*
													1:3	**15.350**	*0*	*31.920*
													1:2	59,144	*12,404*	*105,883*
Pediatric	1:3	75,951	*9,409*	*142,492*	1:3	75,951	*9,409*	*142,492*	1:6	1,327	*456*	*2,199*	1:4	**32,417**	*0*	*67,043*
Oncology	1:3[112]	46,962	*11,731*	*82,192*	---[4]	---	---	---	1:10	0	*0*	*0*	1:5	**4,485**	*0*	*9,189*
Psychiatric (GACHs)	1:4	75,490	*0*	*151,211*	1:3	145,182	*27,572*	*262,791*	1:12	63	*0*	*167*	1:6	**18,155**	*0*	*37,961*
Sub-Acute/Transitional	1:4	82,827	*9,008*	*156,645*	1:5	52,289	*2,247*	*102,330*	1:12	2,665	*0*	*6,872*	---[113]	**---**	---	---

[105] State hospitals and free-standing psychiatric hospitals are excluded.
[106] Assumes that nurse staffing regulations would be imposed as an average across all shifts on a given day, or that hospitals would reassign nurses from shifts staffed above the required level on the same day to shifts staffed below that level on the same day (i.e. day shift to night shift).
[107] For AB394 legislative unit and survey unit type crosswalk, see page IV – 2.
[108] Calculated using unrounded estimates. To estimate total deficit dollars, FTEs are multiplied by total yearly paid nursing hours (2000) and by the weighted averages of RN and LVN hourly wages based on the OSHPD data on skill mix: L&D - $35.01, Postpartum, Comb. L&D/PP - $34.22, Med, Surg, combined Med/Surg, Onc. Mixed - $33.28, Emer. , Postanesthesia - $35.10, Pediatric - $34.39, Stepdown, Tele, combined Stepdown/Tele - $33.95, Subacute - $29.33, Psych/GAC -$32.66.
[109] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[110] No proposal.
[111] Applying the stepdown ratio.
[112] Applying the specialty care ratio.
[113] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit, and a Transitional program in a general acute care hospital shall, at a minimum, meet the staffing requirements contained in the Sub-acute and Transitional inpatient care contracts between the Medi-Cal program and the general acute care hospital.

Postanesthesia	1:2	18,813	*4,034*	*33,592*	1:2	18,813	*4,034*	*33,592*	1:3	5,272	*57*	*10,488*	1:2	**18,813**	*4,034*	*33,592*
Mixed	1:3[114]	434,844	*291,399*	*578,289*	1:4[10]	220,348	*142,467*	*298,229*	1:10[10]	2,720	*341*	*5,099*	1:6[10]	**41.239**	*20.570*	*61.907*
													1:5	**104,232**	*61,955*	*146,509*
TOTAL		**1,973,757**	*1,640,711*	*2,306,693*		**1,192,133**	*969,672*	*1,415,096*		**19,389**	*11,837*	*26,903*		**266,729[11]**	*207,382*	*325,160*

Table 5c. Estimated financial impact of total yearly FTE shortage for California general acute care hospitals[115] for each shift, based on a whole number shortage for each shift, by unit type & proposed standard
***SCENARIO 3: Shortages calculated and averaged over entire 17-day sampling period*[116]**

.1.1.1.1 Survey **Unit Type[117]**	**Personnel Costs per Year Needed to Meet the Proposed Ratios**															
	CNA Proposal				**SEIU Proposal**				**CHA Proposal**				**CDHS Proposal**			
	Ratio	Deficit[118] ($1000s)	***.1.1 90%CI*** ***.5.1 lower***	*upper*	Ratio	Deficit ($1000s)	***.2.1 90%CI*** ***.6.1 lower***	*upper*	Ratio	Deficit ($1000s)	***.3.1 90%CI*** ***.7.1 lower***	*upper*	Ratio	Deficit ($1000s)	***.4.1 90%CI*** ***.8.1 lower***	*upper*
Labor and Delivery Only[119]	1:1	88,603	*44,277*	*132,928*	1:2	1,155	*0*	*3,077*	1:3	0	*0*	*0*	1:2	**1,155**	*0*	*3,077*
Postpartum Only	1:5	65,645	*34,456*	*96,834*	1:6	22,557	*8,003*	*37,111*	1:8	1,693	*0*	*4,218*	1:6	**22,557**	*8,003*	*37,111*
Comb. Postpartum/ L&D	---[120]	---	---	---	---[6]	---	---	---	---[6]	---	---	---	1:3	**12,360**	*0*	*27,324*
Stepdown Only	1:3	11,442	*3,025*	*19,860*	1:3	11,442	*3,025*	*19,860*	1:6	0	*0*	*0*	1:4	**736**	*0*	*1,848*
Telemetry Only	1:3	185,086	*94,342*	*275,829*	1:3	185,086	*94,342*	*275,829*	1:10	0	*0*	*0*	1:5	**18,633**	*0*	*37,677*
Comb. Stepdown/Telemetry	1:3[121]	77,811	*25,071*	*130,551*	1:3[7]	77,811	*25,071*	*130,551*	1:6[7]	0	*0*	*0*	1:4[7]	**9,041**	*1,356*	*16,726*
Medical Only	1:3	125,475	*56,176*	*194,774*	1:4	57,096	*24,056*	*90,136*	1:10	0	*0*	*0*	1:6	**2,795**	*0*	*6,356*
													1:5	18,510	*5,704*	*31,315*
Surgical Only	1:3	133,840	*67,146*	*200,534*	1:4	57,033	*21,500*	*92,565*	1:10	0	*0*	*0*	1:6	**8,816**	*0*	*19,461*
													1:5	20,865	*1,597*	*40,133*
Comb.Medical/ Surgical	1:3	522,199	*343,910*	*700,487*	1:4	232,663	*157,292*	*308,035*	1:10	0	*0*	*0*	1:6	**19,629**	*8,136*	*31,123*
													1:5	80,002	*49,017*	*110,988*
Emergency[5]	1:3	15,350	*0*	*31,920*	1:3	15,350	*0*	*31,920*	1:6	0	*0*	*0*	1:4	6.823	*0*	*15.030*
													1:3	**15,350**	*0*	*31,920*
													1:2	59,144	*12,404*	*105,883*
Pediatric	1:3	75,469	*7,183*	*143,754*	1:3	75,469	*7,183*	*143,754*	1:6	504	*0*	*1,342*	1:4	**30,512**	*0*	*65,650*

[114] Applying the Medical/Surgical ratio.
[11]Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence intervals for Scenario 1 based on the 1:5 ratios are ($1000s); Total: 420,232, Lower Confidence Interval: 335,561, and Upper Confidence Interval: 508,876
[115] State hospitals and free-standing psychiatric hospitals are excluded.
[116] Assumes that hospitals would reassign nurses from any shift staffed above the required level to any other shift staffed below that level (i.e., weekday shifts to weekend shifts, spring shifts to winter shifts).
[117] For AB394 legislative unit and survey unit type crosswalk, see page IV – 2.
[118] Calculated using unrounded estimates. To estimate total deficit dollars, FTEs are multiplied by total yearly paid nursing hours (2000) and by the weighted averages of RN and LVN hourly wages based on the OSHPD data on skill mix: L&D - $35.01, Postpartum, Comb. L&D/PP - $34.22, Med, Surg, combined Med/Surg, Onc. Mixed - $33.28, Emer. , Postanesthesia - $35.10, Pediatric - $34.39, Stepdown, Tele, combined Stepdown/Tele - $33.95, Subacute - $29.33, Psych/GAC – $32.66
[119] Estimate based on linear extrapolation from a single surveyed shift in each hospital to the entire 24 hour day and from that day to all 365 days during a calendar year.
[120] No proposal.
[121] Applying the stepdown ratio.

Oncology	1:3[122]	46,088	*11,487*	*80,688*	---[4]	---	---	---	1:10	0	*0*	*0*	1:5	**3,048**	*0*	*7,333*
Psychiatric (GACHs)	1:4	70,188	*283*	*140,093*	1:3	139,796	*28,020*	*251,573*	1:12	25	*0*	*66*	1:6	**13,517**	*0*	*29,390*
Sub-Acute/Transitional	1:4	81,823	*7,768*	*155,878*	1:5	50,494	*419*	*100,570*	1:12	2,672	*0*	*7,123*	---[123]	**---**	---	---
Postanesthesia	1:2	18,813	*4,034*	*33,592*	1:2	18,813	*4,034*	*33,592*	1:3	5,272	*57*	*10,488*	1:2	**18,813**	*4,034*	*33,592*
Mixed	1:3[124]	437,544	*292,952*	*582,135*	1:4[10]	219,450	*140,628*	*298,272*	1:10[10]	0	*0*	*0*	1:6[10]	**36,577**	*15,201*	*57,953*
													1:5	**94,780**	*51,434*	*138,126*
TOTAL		**1,955,375**	*1,623,451*	*2,287,435*		**1,164,215**	944,257	1,384,583		**10,166**	*2,873*	*17,603*		**213,540[11]**	*155,075*	*270,523*

[122] Applying the specialty care ratio.
[123] Commencing January 1, 2002, the nurse-to-patient ratio in a Sub-acute unit, and a Transitional program in a general acute care hospital shall, at a minimum, meet the staffing requirements contained in the Sub-acute and Transitional inpatient care contracts between the Medi-Cal program and the general acute care hospital.
[124] Applying the Medical/Surgical ratio.
[11] Total for CDHS calculated using the 1:6 ratios for Medical , Surgical, and Combined Medical/Surgical, the 1:3 ratio for Emergency, and the 1:6 ratio for Mixed. The total and confidence intervals for Scenario 1 based on the 1:5 ratios are ($1000s); Total: 359,880, Lower Confidence Interval: 274,146, and Upper Confidence Interval: 448,794

EFFECTS OF NURSE STAFFING LEVELS

Data Abstraction Form

[1]**UI#: _____** [2]**Included/Excluded (I/X) _____**

[3]**Author, date: _____**

[4]**Journal: _____**

[5]**Title: _____**

[6]**Abstractor's initials: _____**

.8.1.1 ELIGIBILITY CRITERIA

(All criteria must be met to include)

[7] **Y N** Describes **original research**; reports methods of data collection and analysis

[8] **Y N** Describes **research conducted in the US**

[9] **Y N** Involves **acute-care** or **psychiatric hospitals** (excluding ICU and long-term care units)

[10] **Y N** Reports a **measure of nurse staffing** (nurse-to-patient ratio, skill mix)

.8.2.1 THE STUDY FOCUS

Classes of endpoints examined (Check all that apply):

[11] ___ **patient outcomes** (e.g., skin integrity, nosocomial infections, falls)
[12] ___ **employee endpoints** (e.g., retention, job satisfaction, job safety)
[13] ___ **institutional endpoints** (e.g., personnel costs, LOS, financial viability)
[14] ___ **unclear**
[15] ___ **other**: _____

[16, 17, 18] **Relevant research question(s)/hypothesis (list up to three):**

Appendix I Item C

Number of institutions, by type

[19] ___ University hospital/academic medical center

[20] ___ Non-university hospital

[21]___ Non-university, teaching

[22]___ Non-university, non-teaching

[23] ___ VA hospital

[24] ___ Psychiatric hospital

[25] ___ Children's hospital

[26] ___ Other: _____

[27] ___ Not reported/unclear

Number of institutions, by size

[28] ___ Very large (>500 beds)

[29] ___ Large (>300 beds, •500 beds)

[30] ___ Medium (>100 beds, •300 beds)

[31] ___ Small (•100 beds)

[32] ___ Not reported/unclear

Number of institutions, by location:

[33] ___ Urban

[34] ___ Suburban

[35] ___ Rural

[36] ___ not reported/unclear

.1.1.1.1 Unit of observation, by number of units

[37] ___ Institutions

[38] ___ Nursing units

[39] ___ Licensed nursing personnel

[40] ___ Nurse practitioners

[41] ___ RNs

[42] ___ LPNs, LVNs, Licensed Psychiatric Technicians

[43] ___ Unlicensed assistive personnel

[44] ___ Patients

[45] ___ Other: _____

Number of nursing unit(s), by type

[46] ___ Combined general med-surg

[47] ___ General medical care

[48] ___ General surgical care

[49] ___ Emergency department

[50] ___ Gynecology

[51] ___ Intermediate care (step-down unit)

[52] ___ Labor and delivery

[53] ___ Neurology

[54] ___ Oncology

[55] ___ Orthopedics

[56] ___ Pediatric

[57] ___ Perinatal, including newborn nursery

[58] ___ Postanesthesia

[59] ___ Psychiatric/behavioral health

[60] ___ Rehabilitation

[61] ___ Telemetry unit

[62] ___ Transplant

[63] other: _____

[64] other: _____

[65] other: _____

[66] ___ Not reported/unclear

STUDY DESIGN

Study design:

[67] ___ retrospective (data collected before research question was posed)

[68] ___ cross-sectional survey

[69] ___ prospective (data collected prospectively, after question was posed)

Nurse staffing measure(s) reported (nurse-patient ratio; hours worked)

[70] Numerator/denominator (units): _____

[71] Numerator/denominator (units): _____

[72] Numerator/denominator (units): _____

Skill mix

[73] Defined as: (numerator/denominator) _____

Record values when held constant throughout study (include ranges):

[74] ___ % RN

[75] ___ % LVN, LPN, LPT

[76] ___ % UAP

[77] ___ % Other

Analysis adjusted for:

[78] **Y N** patient acuity/case mix [If no, note under internal validity]

[79] **Y N** skill mix [If no, note under internal validity]

[80] other: _____

[81] other: _____

[82] other: _____

.1.1.1.1 ***[83]*** *Duration of study (months):* ____

.1.2.1 Quality Evaluation

Internal validity

[84] ___ Study design (**2** = prospective; **1** = retrospective; **0** = cross-sectional)

[85] ___ Unit of reporting (**2** = each unit; **1** = class of unit; **0** = larger grouping)

[86] ___ Potential for bias: (**2** = low; **1** = moderate; **0** = high)

[87] **Notes:**

_____

Generalizability

[88] ___ Date data collected (2 = 1995 or later; 1 = 1990-94; 0 = 1989 or before)

[89] ___ Number of hospitals included (2 = 10 or more; 1 = 2 to 9; 0 = 1)

[90] ___ Number of nursing units studied (2 = 10 or more; 1 = 4 to 9; 0 = 1 to 3)

[91] **Notes:**

_____

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Outcome variable(s):

.1	*Variable*	*.2.1*	*How Reported*	*Source of Data*
	[92] ***1.***		*[93]*	*[94]*
	[95] ***2.***		*[96]*	*[97]*
1	*[98]* ***3.***	***1***	*[99]*	***1*** *[100]*
1	*[101]* ***4.***	***1***	*[102]*	***1*** *[103]*
1	*[104]* ***5.***	***1***	*[105]*	***1*** *[106]*
1	*[107]* ***6.***	***1***	*[108]*	***1*** *[109]*
[110] **7.**		***1***	*[111]*	***1*** *[112]*
[113] **8.**		***1***	*[114]*	***1*** *[115]*

[116] **9.**	***1*** *[117]*	***1*** *[118]*

.27.1.1 RESULTS

Results associated with variations in nurse-patient ratios or in skill mix:

Result	Size of Effect (#, •, r, P, β, etc.)
[119] **1.**	[120]
[121] **2.**	[122]
[123] **3.**	[124]
[125] **4.**	[126]
[127] **5.**	[128]
[129] **6.**	[130]
[131] **7.**	[132]
[133] **8.**	[134]
[135] **9.**	[136]
[137] **10.**	[138]

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Results NOT associated with variations in nurse-patient ratios or in skill mix:

Result	Size of Effect (#, •, r, P, β, etc.)
[139] **1.**	[140]
[141] **2.**	[142]
[143] **3.**	[144]
[145] **4.**	[146]
[147] **5.**	[148]
[149] **6.**	[150]
[151] **7.**	[152]
[153] **8.**	[154]
[155] **9.**	[156]
[157] **10.**	[158]

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Appendix I Item C

Stated Limitations of the Study

[159] **1.**

[160] **2.**

[161] **3.**

[162] **4.**

[163] **5.**

[164] **6.**

[165] **7.**

[166] **8.**

[167] **9.**

[168] **10.**

[169] **Notes:**

Appendix I Table A. The Nursing Evidence Report Advisory Committee

Debbie Aspling, RN, MSN
Nurse Administrator
Lodi Memorial Hospital
Lodi, California

Zona Freeman, RN, MScN
Assistant Nurse Manager
Sutter Health
Carmichael, California

Jennifer Jacoby, RN, MSN
Vice President, Patient Care Services Administration
Sharp Memorial Hospital
San Diego, California

Gerald Kominski, PhD
Professor
UCLA School of Public Health
Department of Health Services
Los Angeles, California

Carol Robinson, RN, MPA
Associate Director, Hospital and Clinical Patient Care Services
UC Davis Medical Center Hospital,
University of California, Davis
Sacramento, California

Margaret D. Sovie, RN, PhD
Professor of Nursing Administration
School of Nursing
University of Pennsylvania
Philadelphia, Pennsylvania

Appendix I Table B. Strategies for the Literature Searches:
Quantitative Summary of the Electronic Database and Hand Searches

The results of the search strategies of the PubMed, CINAHL, ABI/Inform, Web of Science databases, and hand searches of bibliographies, are summarized below. Totals of citations reviewed are results unduplicated by other searches.

.28.1 ***.29.1 Search Document or Database***	**Source Type and Search Criteria**	**Total Unduplicated Citations Reviewed**	**Citations Retrieved and Abstracted**
IOM (Wunderlich, Sloan, Davis, *Eds*). 1996. *Nursing Staff in Hospitals and Nursing Homes, Is It Adequate?* National Academy Press.	Bibliography	441	19
Sovie, Gift, Jawad, Stratton, Wallace, Aiken, Reed 2000. *Hospital Restructuring's Impact on Outcomes*. National Institute of Nursing Research Study.	Bibliography	124	27
PubMed Search 1	1. Personnel Staffing and Scheduling 2. ratio OR ratios 3. nurse OR nurses OR nursing 4. #1 AND #2 AND #3 5. ratio [ti] OR ratios [ti] 6. patient OR patients 7. nurse [ti] OR nurses [ti] OR nursing [ti] 8. #5 AND #6 AND #7 9. #4 OR #8	54	24
PubMed Search 2	1. Nursing Staff OR Nursing Service 2. Personnel Staffing and Scheduling [majr] 3. #1 AND #2 4. nurs* [ti] AND staff* [ti] AND level* [ti] 5. #3 OR #4 6. Limits: Publication Date from 1995 to 2000, English	156	22
PubMed Search 3	1. Nursing Staff/supply & distribution 2. Personnel Staffing and Scheduling [majr] 3. #1 AND #2 NOT Nursing Homes NOT Intensive Care Units 4. Limits: Publication Date from 1990 to 2000, English	461	111
ABI/Inform	f su nurses and su hospitals and su	63	13

.28.1 ***.29.1 Search Document or Database***	**Source Type and Search Criteria**	**Total Unduplicated Citations Reviewed**	**Citations Retrieved and Abstracted**
	workforce planning		
Web of Science	(nurse OR nurses OR nursing) AND (patient OR patients) AND (ratio OR ratios) (Limited to title words) (nurse OR nurses OR nursing) AND (staff OR staffing) AND (ratio OR ratios) (Limited to title words)	12	8
CINAHL	nurse$ with patient$ with ratio$ (as text words) $ = truncation symbol with = requires the words to be within the same sentence	160	19
CDL Melvyl	exact subject Nursing Staff--supply & distribution [or] exact subject Nurses--Supply and demand--United States [and-not] exact subject Nursing homes	47	30
Jacoby Bib		10	10
Peggy's Internet	Pubmed Search 1: "P. Buerhaus" (2 results) Pubmed Search 2: "Intensive Care" (10 results)	28	28
(Aiken 2000) "related articles" via PubMed		103	25
Lichtig, Rowell, Knauf 2000. Nurse Staffing and Patient Outcomes in the Hospital Inpatient Setting. Unpublished mss. as of 4/01	Bibliography	14	5
Spetz, Seago, Coffman, Rosenoff, O'Neil 2000. (UCSF Study) Minimum Nurse Staffing Ratios in California Acute Care Hospitals. California. Sponsored by: HealthCare Foundation	Bibliography	68	4
Other References Identified from Articles Reviewed for Abstraction: (Blegen & Goode, Baker, Bordoli, Chang, Davis, Flood & Diers, Fridkin, Gosnel, Kraphol, Mitchell, Reed, Blegen & Vaughn, Miscellaneous)		100	98
IHSP search for CNA: "RN Staffing Ratios: Initial Bibliographic Compilation" (947 items), "Registered		947 + 57 + 20 =1024	24

.28.1 *.29.1* ***Search Document or Database***	**Source Type and Search Criteria**	**Total Unduplicated Citations Reviewed**	**Citations Retrieved and Abstracted**
Nurses and Skill Mix" (57 items), reference list in personal communication 4/27/00			
	TOTAL	**2870**	**456**